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(54) Title: AVIAN TRANSGENESIS USING A CHICKEN OVALBUMIN GENE REGION

(57) Abstract: The present invention provides isolated and recombinant avian nucleic acid molecules comprising at least one avian MAR and an avian nucleic acid sequence encoding an ovalbumin transcriptional regulatory region. The isolated nucleic acid of the present invention is useful for reducing chromosomal positional effects upon the transcription of a transgene operably linked to the ovalbumin transcriptional regulatory region and transfected into a recipient avian cell. The recombinant nucleic acid molecules of the present invention may further comprise a polyadenylation signal sequence or an avian 3' domain, and optionally, an internal ribosome entry site for expression of an operably linked heterologous nucleic acid insert in a transfected avian cell.



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Title of the Invention

AVIAN TRANSGENESIS USING A CHICKEN OVALBUMIN GENE REGION

5 The present application claims priority from U.S. provisional patent applications, Serial Nos. 60/462,953, filed April 15, 2003; 60/465,215, filed April 24, 2003; and 60/469,488 filed May 9, 2003, all of which are hereby incorporated by reference herein in their entireties.

Field of the Invention

The present invention relates generally to an isolated nucleic acid molecule comprising an avian ovalbumin transcriptional regulatory control region and linked matrix attachment regions. The invention further relates to recombinant nucleic acids and expression vectors, genetically transformed cells and transgenic avians that comprise an avian ovalbumin transcriptional regulatory region operably linked to a heterologous polypeptide-encoding nucleic acid insert. The present invention also relates to the expression and production of the polypeptide-encoding nucleic acid molecule under the control of the isolated avian ovalbumin transcriptional regulatory region.

Background

Transgenic technology to convert animals into "bioreactor" for the production of specific proteins or other substances of pharmaceutical interest (Gordon *et al.*, 1987, *Biotechnology* 5: 1183-1187; Wilmut *et al.*, 1990, *Theriogenology* 33: 113-123) offers significant advantages over more conventional methods of protein production by gene expression.

Recombinant nucleic acid molecules have been engineered so that an expressed heterologous protein may be joined to a protein or peptide that allows secretion of the transgenic expression product into milk or urine, from which the protein may then be recovered. These procedures may require lactating animals, with the attendant costs of maintaining individual animals or herds of large species, such as cows, sheep, or goats.

Historically, transgenic animals have been produced almost exclusively by microinjection of the fertilized egg. The pronuclei of fertilized eggs are microinjected *in vitro* with foreign, i.e., xenogeneic or allogeneic, heterologous DNA or hybrid DNA molecules. The microinjected fertilized eggs are then transferred to
5 the genital tract of a pseudopregnant female (e.g., Krimpenfort *et al.*, U.S. Pat. No. 5,175,384).

One system that holds potential is the avian reproductive system. The production of an avian egg begins with formation of a large yolk in the ovary of the hen. The unfertilized oocyte or ovum is positioned on top of the yolk sac. After
10 ovulation, the ovum passes into the infundibulum of the oviduct where it is fertilized if sperm are present, and then moves into the magnum of the oviduct, which is lined with tubular gland cells. These cells secrete the egg-white proteins, including ovalbumin, lysozyme, ovomucoid, conalbumin and ovomucin, into the lumen of the magnum where they are deposited onto the avian embryo and yolk.

15 The hen oviduct offers outstanding potential as a protein bioreactor because of the high levels of protein production, the promise of proper folding and post-translation modification of the target protein, the ease of product recovery, and the shorter developmental period of chickens compared to other potential animal species. The chicken ovalbumin gene is highly expressed in the tubular glands of the mature
20 hen oviduct and is therefore a suitable candidate for an efficient promoter for heterologous protein production in transgenic birds. Efforts have been made to create transgenic chickens expressing heterologous proteins in the oviduct by means of microinjection of DNA (PCT Publication WO 97/47739).

Gene expression must be considered not only from the perspective of cis-
25 regulatory elements associated with a gene, and their interactions with trans-acting elements, but also with regard to the genetic environment in which they are located. Chromosomal positioning effects result in variations in levels of transgene expression associated with different locations of the transgene within the recipient genome. An important factor governing the level of transgene expression is the chromatin
30 structure around a transgene, and how it cooperates with the cis-regulatory elements. While the deletion of a cis-regulatory element from a transgenic lysozyme locus can

be sufficient to reduce or eliminate positional independence of the level of gene expression, there is also evidence that positional independence conferred on a transgene requires the cotransfer of many kilobases of DNA other than just the protein encoding region and the immediate cis-transcriptional regulatory elements.

5 Scattered throughout the chicken genome, including the chicken ovalbumin locus, are short sequences that resemble features of Long Terminal Repeats (LTRs) of retrovirus. The function of these elements is unclear but most likely may help define the DNase hypersensitive (DHS) regions of a gene locus (Stein et al., 1983, *Proc. Natl. Acad. Sci. U.S.A.* 80: 6485-6489). Thus, flanking various avian genes are matrix
10 attachment regions (5' and 3' MARs), alternatively referred to as "scaffold attachment regions" or SARs. The outer boundaries of the chicken lysozyme locus, for example, have been defined by the MARs (Phi-Van et al., 1988, *E.M.B.O.J.* 7: 655-664; Phi-Van & Stratling., 1996, *Biochem.* 35: 10735-10742). Deletion of a 1.32 kb or a 1.45 kb region, each comprising half of a 5' MAR, reduces positional variation in the level
15 of transgene expression (Phi-Van & Stratling, supra).

The 5' matrix attachment region (5' MAR), located about -11.7 kb upstream of the chicken lysozyme transcription start site, can increase the level of gene expression by limiting the chromosomal positional effects exerted against a transgene (Phi-Van et al., 1988, *supra*). At least one other MAR is located 3' downstream of the protein
20 encoding region. Although MAR nucleic acid sequences are conserved, little cross-hybridization is seen, indicating significant overall sequence variation. However, MARs of different species can interact with the nucleomatrixes of heterologous species, to the extent, for example, that the chicken lysozyme MAR can associate with the plant tobacco nucleomatrix as well as that of the chicken oviduct cells
25 (Mlynarona et al., 1994, *Cell* 6: 417-426; von Kries et al., 1990, *Nucleic Acids Res.* 18: 3881-3885). The lysozyme promoter region of chicken is also active when transfected into mouse fibroblast cells and linked to a reporter gene such as the bacterial chloramphenicol acetyltransferase gene. In each case, the presence of a 5' MAR element increased positional independency of the level of transcription (Stief et
30 al., 1989, *Nature* 341: 343-345; Sippel et al., pgs. 257 - 265 in Houdeline L.M. (ed), "Transgenic Animals: Generation and Use").

The ability to direct the insertion of a transgene into a site in the genome of an animal where the positional effect is limited offers predictability of results during the development of a desired transgenic animal, and increased yields of the expressed product. Sippel and Steif disclose, in U.S. Patent No. 5,731,178, methods to increase
5 the expression of genes introduced into eukaryotic cells by flanking a transcription unit with scaffold attachment elements, in particular the 5' MAR isolated from the chicken lysozyme gene. The transcription unit disclosed by Sippel and Steif was an artificial construct that combined only the -6.1 kb enhancer element and the proximal promoter element (base position -579 to +15) from the lysozyme gene. Other
10 promoter associated elements were not included.

Although individual cis-transcriptional regulatory elements associated with the chicken ovalbumin gene have been isolated and sequenced, together with short regions of flanking DNA, the entire nucleic acid sequence comprising the 5' upstream region of the ovalbumin gene has not been determined and has not been employed as
15 a functional promoter to allow expression of a heterologous transgene.

What are still needed, however, are efficient transcription promoters that allow expression of transgenes in avian cells but with reduced positional variation.

What is also still needed is a gene expression promoter cassette that will allow expression of a transgene in the oviduct cells of an avian and efficient gene
20 expression regardless of the chromosomal location of the expression system.

Summary of the Invention

Briefly described, the present invention relates to novel isolated and recombinant nucleic acid molecules that comprise an avian ovalbumin transcriptional
25 regulatory region and at least one matrix attachment region element.

The isolated and recombinant nucleic acid molecules of the present invention, because of the presence of at least one matrix attachment region, are useful for reducing chromosomal positional effects on a transgene operably linked to the ovalbumin transcriptional regulatory region and transfected into a recipient cell.
30 Isolating an approximately 195 kb region of the chicken genome that includes regions upstream of the ovalbumin locus ensures that cis-elements are also included that will

allow gene expression in a tissue-specific manner. The ovalbumin promoter region of the present invention, therefore, will allow expression of an operably linked heterologous nucleic acid insert by a transfected avian cell such as, for example, a somatic cell.

5 The present invention provides a novel isolated nucleic acid molecule of approximately 195 kb of the chicken genome, and truncated variants thereof, comprising a region of about 135 kb that is 5' upstream, and an approximately 45 kb region that is 3' downstream, of the ovalbumin-encoding region of the gene locus. The novel isolated chicken nucleic acid sequence includes matrix attachment regions
10 both 5' and 3' of the ovalbumin gene and an ovalbumin transcriptional regulatory region that includes CR1 repeat elements, a proximal ovalbumin promoter. Interspersed among the elements are stretches of nucleic acid that serve at least to organize the elements in an ordered array. The novel isolated chicken genomic region also includes the ovalbumin-encoding region with a plurality of introns
15 dispersed therein.

 The present invention further provides recombinant nucleic acid molecules for operably linking an avian ovalbumin transcriptional regulatory region to a heterologous nucleic acid molecule insert encoding a polypeptide to be expressed by a transfected or transgenic cell. The heterologous nucleic acid molecule may be
20 placed in frame with a signal peptide sequence. Translation initiation may start with the signal peptide and continue through the nucleic acid molecule to produce an expressed polypeptide having the desired amino acid sequence.

 The sequence of the expressed heterologous nucleic acid insert may be optimized for codon usage by a host cell using approaches well known in the art. For
25 example, codon usage may be optimized for an avian such as a chicken. This could be determined from the codon usage of at least one, and preferably more than one, protein expressed in a chicken cell. For example, the codon usage may be determined from the nucleic acid sequences encoding the proteins ovalbumin, lysozyme, ovomucin and ovotransferrin of chicken.

30 The recombinant nucleic acid molecules of the present invention may further comprise a polyadenylation signal sequence that allows transcription directed by an

ovalbumin transcriptional regulatory region to extend beyond the heterologous nucleic acid encoding a desired heterologous polypeptide and to comprise a 3' untranslated region and a polyadenylated tail. Any suitable functional polyadenylation signal sequence may be linked to the 3' end of the heterologous nucleic acid insert, including the SV40 polyadenylation signal sequence, bovine growth hormone adenylation sequence or the like.

The recombinant nucleic acid molecules of the present invention may also comprise a chicken ovalbumin 3' domain. The 3' domain can include a 3' untranslated region of the ovalbumin gene, a polyadenylation signal and at least one MAR that, in combined action with an MAR upstream of the ovalbumin transcriptional regulatory region, may reduce positional variation in gene expression in transgenic avians.

Yet another aspect of the present invention is expression vectors suitable for delivery to a recipient cell, preferably an avian cell. The expression vectors provided by the present invention may comprise an avian ovalbumin transcriptional regulatory region that can be operably linked to a nucleic acid insert encoding a polypeptide, and optionally a polyadenylation signal sequence. The expression vectors of the present invention further comprise at least one MAR element, and preferably two MARs that flank the ovalbumin transcriptional regulatory region and which can non-randomly direct the insertion of the expression vector into the genome of a recipient eukaryotic cell. The expression vector may further comprise a bacterial plasmid sequence, a viral nucleic acid sequence, or fragments or variants thereof that may allow for replication of the vector in a suitable host.

Another aspect of the present invention is methods of expressing a heterologous polypeptide in a eukaryotic cell by transfecting the cell with a recombinant nucleic molecule comprising an avian ovalbumin transcriptional regulatory region operably linked to a nucleic acid insert encoding a polypeptide desired to be expressed and, optionally, a polyadenylation signal sequence, and culturing the transfected cell under conditions suitable for expression of the heterologous polypeptide under the control of the avian ovalbumin transcriptional regulatory region.

Also within the scope of the present invention are recombinant cells, tissues and animals containing non-naturally occurring recombinant nucleic acid molecules according to the present invention as described above. In one embodiment of the present invention, the transformed cell is a chicken oviduct cell and the nucleic acid insert comprises the chicken ovalbumin transcriptional regulatory region, a nucleic acid insert encoding a human interferon $\alpha 2b$ that is codon optimized for expression in an avian cell, and an SV40 polyadenylation sequence. In another embodiment of the present invention, the nucleic acid insert encodes the heavy and light chains of an antibody.

Additional objects and aspects of the present invention will become more apparent upon review of the detailed description set forth below when taken in conjunction with the accompanying figures, which are briefly described as follows.

Brief Description of the Figures

Fig. 1 illustrates the nucleic acid sequence SEQ ID NO: 1 of a region of the chicken genome that includes a chicken ovalbumin transcriptional regulatory region and the chicken ovalbumin gene, and matrix attachment regions 5' upstream and 3' downstream thereof.

Fig. 2 schematically illustrates the chicken genomic region having nucleic acid sequence SEQ ID NO: 1, indicating the relative positions and orientations of regions having identity with known domains.

Fig. 3 illustrates schematically the construction of an expression bacterial artificial chromosome where the insert gene of interest is under the expression control of the chicken ovalbumin promoter. Genes of interest may be inserted into the native translation start site of the ovalbumin gene. L and roman numerals, ovalbumin exons; GOI, gene of interest; start, translation start site; stop, translation stop site; pA, polyadenylation signal; E, EcoRI site.

Fig. 4 illustrates an SV40 polyadenylation signal sequence SEQ ID NO: 2.

Fig. 5 illustrates the nucleotide sequence SEQ ID NO: 3 of a human interferon $\alpha 2b$ interferon optimized for expression in an avian cell.

Fig. 6 illustrates the reconstruction of the chicken genomic region containing the ovalbumin locus.

Detailed Description of the Preferred Embodiments

5 This description uses gene nomenclature accepted by the Cucurbit Genetics Cooperative as it appears in the *Cucurbit Genetics Cooperative Report* 18:85 (1995), which are incorporated herein by reference in its entirety. Using this gene nomenclature, genes are symbolized by italicized Roman letters. If a mutant gene is recessive to the normal type, then the symbol and name of the mutant gene appear in
10 italicized lower case letters.

For convenience, definitions of certain terms employed in the specification, examples, and appended claims are collected here.

Definitions

The term “avian” as used herein refers to any species, subspecies or race of
15 organism of the taxonomic class *ava*, such as, but not limited to chicken, turkey, duck, goose, quail, pheasants, parrots, finches, hawks, crows and ratites including ostrich, emu and cassowary. The term includes the various known strains of *Gallus gallus*, or chickens, (for example, White Leghorn, Brown Leghorn, Barred-Rock, Sussex, New Hampshire, Rhode Island, Ausstralorp, Minorca, Amrox, California
20 Gray, Italian Partidge-colored), as well as strains of turkeys, pheasants, quails, duck, ostriches and other poultry commonly bred in commercial quantities. It also includes an individual avian organism in all stages of development, including embryonic and fetal stages. The term “avian” also may denote “pertaining to a bird”, such as “an avian (bird) cell.”

25 The term “nucleic acid” as used herein refers to any natural or synthetic linear and sequential array of nucleotides and nucleosides, for example cDNA, genomic DNA, mRNA, tRNA, oligonucleotides, oligonucleosides and derivatives thereof. For ease of discussion, such nucleic acids may be collectively referred to herein as “constructs,” “plasmids,” or “vectors.” The term “nucleic acid” further includes
30 modified or derivatized nucleotides and nucleosides such as, but not limited to, halogenated nucleotides such as, but not only, 5-bromouracil, and derivatised

nucleotides such as biotin-labeled nucleotides.

The term "isolated nucleic acid molecule" as used herein refers to a nucleic acid molecule with a structure not identical to a naturally occurring nucleic acid molecule and includes DNA, RNA, or derivatives or variants thereof. The term
5 covers, but is not limited to, (a) a DNA which has the sequence of part of a naturally occurring genomic molecule but is not flanked by at least one of the coding sequences that flank that part of the molecule in the genome of the species in which it naturally occurs; (b) a nucleic acid incorporated into a vector or into the genomic nucleic acid of a prokaryote or eukaryote in a manner such that the resulting molecule is not
10 identical to any vector or naturally occurring genomic DNA; (c) a separate molecule such as a cDNA, a genomic fragment, a fragment produced by polymerase chain reaction (PCR), ligase chain reaction (LCR) or chemical synthesis, or a restriction fragment; (d) a recombinant nucleotide sequence that is part of a hybrid gene, i.e., a gene encoding a fusion protein, and (e) a recombinant nucleotide sequence that is part
15 of a hybrid sequence that is not naturally occurring. Isolated nucleic acid molecules of the present invention can include, for example, natural allelic variants as well as nucleic acid molecules modified by nucleotide deletions, insertions, inversions, or substitutions such that the resulting nucleic acid molecule still essentially encodes an ovalbumin transcriptional regulatory region or a variant thereof of the present
20 invention.

The terms "polynucleotide," "oligonucleotide," and "nucleic acid sequence" are used interchangeably herein and include, but are not limited to, coding sequences (polynucleotide(s) or nucleic acid sequence(s) which are transcribed and translated into polypeptide *in vitro* or *in vivo* when placed under the control of appropriate
25 regulatory or control sequences); control sequences (e.g., translational start and stop codons, promoter sequences, ribosome binding sites, polyadenylation signals, transcription factor binding sites, transcription termination sequences, upstream and downstream regulatory domains, enhancers, silencers, and the like); and regulatory sequences (DNA sequences to which a transcription factor(s) binds and alters the
30 activity of a gene's promoter either positively (induction) or negatively (repression)).

No limitation as to length or to synthetic origin are suggested by the terms described above.

As used herein the terms "peptide," "polypeptide" and "protein" refer to a polymer of amino acids in a serial array, linked through peptide bonds. A "peptide" typically is a polymer of at least two to about 30 amino acids linked in a serial array by peptide bonds. The term "polypeptide" includes proteins, protein fragments, protein analogues, oligopeptides and the like. The term "polypeptides" contemplates polypeptides as defined above that are encoded by nucleic acids, produced through recombinant technology (isolated from an appropriate source such as a bird), or synthesized. The term "polypeptides" further contemplates polypeptides as defined above that include chemically modified amino acids or amino acids covalently or noncovalently linked to labeling moieties.

The term "fragment" as used herein refers to any isolated portion of the subject nucleic acid molecule constructed artificially (e.g., by chemical synthesis) or by cleaving a natural product into multiple pieces, using restriction endonucleases or mechanical shearing, or a portion of a nucleic acid synthesized by DNA polymerase, including by PCR, or any other polymerizing technique well known in the art, or expressed in a host cell by recombinant nucleic acid technology well known to one of skill in the art. The term "fragment" as used herein may also refer to an isolated portion of a polypeptide, wherein the portion of the polypeptide is cleaved from a naturally occurring polypeptide by proteolytic cleavage by at least one protease, or is a portion of the naturally occurring polypeptide synthesized by chemical or recombinant methods well known to one of skill in the art.

The terms "recombinant nucleic acid" and "recombinant DNA" as used herein refer to combinations of at least two nucleic acid sequences that are not naturally found in a eukaryotic or prokaryotic cell. The nucleic acid sequences may include, but are not limited to, nucleic acid vectors, gene expression regulatory elements, origins of replication, suitable gene sequences that when expressed confer antibiotic resistance, protein-encoding sequences and the like. The term "recombinant polypeptide" is meant to include a polypeptide produced by recombinant DNA techniques. A recombinant polypeptide may be distinct from a naturally occurring

polypeptide either in its location, purity or structure. Generally, a recombinant polypeptide will be present in a cell in an amount different from that normally observed in nature.

The term "gene" or "genes" as used herein refers to nucleic acid sequences
5 that encode genetic information for the synthesis of a whole RNA, a whole protein, or any portion of such whole RNA or whole protein. Genes that are not naturally part of a particular organism's genome are referred to as "foreign genes," "heterologous genes" or "exogenous genes" and genes that are naturally a part of a particular organism's genome are referred to as "endogenous genes". The term "gene product"
10 refers to an RNA or protein that is encoded by the gene. "Endogenous gene products" are RNAs or proteins encoded by endogenous genes. "Heterologous gene products" are RNAs or proteins encoded by "foreign, heterologous or exogenous genes" and are, therefore, not naturally expressed in the cell.

The term "expressed" or "expression" as used herein refers to the transcription
15 from a gene to give an RNA nucleic acid molecule at least complementary in part to a region of one of the two nucleic acid strands of the gene. The term "expressed" or "expression" as used herein may also refer to the translation from an RNA molecule to give a protein, a polypeptide or a portion thereof.

As used herein, the term "locus" refers to the site of a gene on a chromosome.
20 In diploid organisms, pairs of genes control hereditary traits, each in the same position on a pair of chromosomes. These gene pairs, or alleles, may both be dominant or both be recessive in expression of that trait. In either case, the individual is said to be homozygous for the trait controlled by that gene pair. If the gene pair (alleles) consists of one dominant and one recessive trait, the individual is
25 heterozygous for the trait controlled by the gene pair.

The term "operably linked" refers to an arrangement of elements wherein the components so described are configured so as to perform their usual function. Control sequences operably linked to a coding sequence are capable of effecting the expression of the coding sequence. The control sequences need not be contiguous
30 with the coding sequence, so long as they function to direct the expression thereof. For example, intervening untranslated yet transcribed sequences can be present

between a promoter sequence and the coding sequence and the promoter sequence can still be considered "operably linked" to the coding sequence.

The term "transcription regulatory sequences" as used herein refers to nucleotide sequences that are associated with a gene nucleic acid sequence and which regulate the transcriptional expression of the gene. Exemplary transcription regulatory sequences include enhancer elements, hormone response elements, steroid response elements, negative regulatory elements, and the like.

The term "promoter" as used herein refers to the DNA sequence that determines the site of transcription initiation by an RNA polymerase. A "promoter-proximal element" is a regulatory sequence generally within about 200 base pairs of the transcription start site.

The term "matrix attachment region" as used herein refers to a region of a eukaryotic genomic DNA that can be bound to chromosomal scaffold proteins. Matrix (scaffold) attachment regions (MARs) are generally located between transcription units such that the transcription units are within chromosomal loops. The bases of the loops are connected to the scaffold proteins through the MAR at each base. MARs and MAR-like homologs are identified as several recognizable nucleic acid sequences including, but not limited to, TG-rich spans, AT-rich regions and consensus sequences as described by Wang et al, *J. Biol. Chem.* 270:23239-23242 (1995). MARs may be identified by using suitable software such as, for example, MAR-WIZTM (Futuresoft, Michigan, USA)

The term "internal ribosome entry sites (IRES)" as used herein refers to a region of a nucleic acid, most typically an RNA molecule, wherein eukaryotic initiation of protein synthesis occurs far downstream of the 5' end of the RNA molecule. A 43S pre-initiation complex comprising the eIF2 protein bound to GTP and Met-tRNA^{Met}, the 40S ribosomal subunit, and factors eIF3 and 31f1A may bind to an "IRES" before locating an AUG start codon. An "IRES" may be used to initiate translation of a second coding region downstream of a first coding region, wherein each coding region is expressed individually, but under the initial control of a single upstream promoter. An "IRES" may be located in a eukaryotic cellular mRNA.

The term "coding region" as used herein refers to a continuous linear

arrangement of nucleotides which may be translated into a polypeptide. A full length coding region is translated into a full length protein; that is, a complete protein as would be translated in its natural state absent any post-translational modifications. A full length coding region may also include any leader protein sequence or any other
5 region of the protein that may be excised naturally from the translated protein.

The terms “complementary”, “complementarity” or “complement” as used herein refers to two nucleic acid molecules that can form specific interactions with one another to form a base-paired double helix.

The term “probe” as used herein, when referring to a nucleic acid, refers to a
10 nucleotide sequence that can be used to anneal or hybridize with and thereby identify the presence of a complementary sequence, or a complementary sequence differing from the probe sequence but not to a degree that prevents hybridization under the hybridization stringency conditions used. The probe may be modified with labels such as, but not only, radioactive groups, biotin, and the like that are well known in
15 the art.

The term “hybridizing under stringent conditions” as used herein refers to annealing a first nucleic acid to a second nucleic acid under stringent conditions as defined below. Stringent hybridization conditions typically permit the hybridization of nucleic acid molecules having at least 70% nucleic acid sequence complementarity
20 with the nucleic acid molecule being used as a probe in the hybridization reaction, e.g., high temperature and/or low salt content that tend to disfavor hybridization of dissimilar nucleotide sequences. Alternatively, hybridization of the first and second nucleic acid may be conducted under reduced stringency conditions, e.g., low temperature and/or high salt content that tend to favor hybridization of dissimilar
25 nucleotide sequences. Low stringency hybridization conditions may be followed by high stringency conditions or intermediate medium stringency conditions to increase the selectivity of the binding of the first and second nucleic acids. The hybridization conditions may further include reagents such as, but not limited to, dimethyl sulfoxide (DMSO) or formamide to disfavor still further the hybridization of dissimilar
30 nucleotide sequences. A suitable hybridization protocol may, for example, involve hybridization in 6X SSC (wherein 1X SSC comprises 0.015 M sodium citrate and

0.15 M sodium chloride), at 65° Celsius in an aqueous solution, followed by washing with 1X SSC at 65° Celsius. Formulae to calculate appropriate hybridization and wash conditions to achieve hybridization permitting 30% or less mismatch between two nucleic acid molecules are disclosed, for example, in Meinkoth et al., 1984, *Anal. Biochem.* 138: 267-284; the content of which is incorporated herein by reference in its entirety. Protocols for hybridization techniques are well known to those of skill in the art and standard molecular biology manuals may be consulted to select a suitable hybridization protocol without undue experimentation. See, for example, Sambrook et al., 1989, "Molecular Cloning: A Laboratory Manual", 2nd ed., Cold Spring Harbor Press, the contents of which are herein incorporated by reference in its entirety.

Typically, stringent conditions will be those in which the salt concentration is less than about 1.5 M Na ion, typically about 0.01 to 1.0 M Na ion concentration (or other salts) from about pH 7.0 to about pH 8.3 and the temperature is at least about 30° Celsius for short probes (e.g., 10 to 50 nucleotides) and at least about 60° Celsius for long probes (e.g., greater than 50 nucleotides). Stringent conditions may also be achieved with the addition of destabilizing agents such as formamide. Exemplary low stringency conditions include hybridization with a buffer solution of 30 to 35% formamide, 1 M NaCl, 1% SDS (sodium dodecyl sulphate) at 37° Celsius, and a wash in 1x to 2x SSC at 50 to 55° Celsius. Exemplary moderate stringency conditions include hybridization in 40 to 45% formamide, 1 M NaCl, 1% SDS at 37° Celsius, and a wash in 0.5x to 1x SSC at 55 to 60° Celsius. Exemplary high stringency conditions include hybridization in 50% formamide, 1 M NaCl, 1% SDS at 37° Celsius, and a wash in 0.1x SSC at 60 to 65° Celsius.

The terms "percent sequence identity" as used herein refers to the degree of sequence identity between two nucleic acid sequences or two amino acid sequences as determined using the algorithm of Karlin & Attschul, 1990, *Proc. Natl. Acad. Sci.* 87: 2264-2268, modified as in Karlin & Attschul, 1993, *Proc. Natl. Acad. Sci.* 90: 5873-5877. Such an algorithm is incorporated into the NBLAST and XBLAST programs of Attschul et al., 1990, *J. Mol. Biol.* Q15: 403-410. BLAST nucleotide searches are performed with the NBLAST program, score = 100, wordlength = 12, to

obtain nucleotide sequences homologous to a nucleic acid molecule of the invention. BLAST protein searches are performed with the XBLAST program, score = 50, wordlength = 3, to obtain amino acid sequences homologous to a reference polypeptide. To obtain gapped alignments for comparison purposes, Gapped BLAST
5 is utilized as described in Attschul *et al.*, 1997, *Nucl. Acids Res.* 25: 3389-3402. When utilizing BLAST and Gapped BLAST programs, the default parameters of the respective programs (e.g. XBLAST and NBLAST) are used. Other algorithms, programs and default settings may also be suitable such as, but not only, the GCG-Sequence Analysis Package of the U.K. Human Genome Mapping Project Resource
10 Centre that includes programs for nucleotide or amino acid sequence comparisons.

The terms "vector" or "nucleic acid vector" as used herein refer to a natural or synthetic single or double stranded plasmid or viral nucleic acid molecule (RNA or DNA) that can be transfected or transformed into cells and replicate independently of, or within, the host cell genome. The term "expression vector" as used herein refers to
15 a nucleic acid vector that comprises a transcription regulatory region operably linked to a site wherein is, or can be, inserted, a nucleotide sequence to be transcribed and, optionally, to be expressed, for instance, but not limited to, a sequence coding at least one polypeptide.

The term "transfection" as used herein refers to the process of inserting a
20 nucleic acid into a host cell. Many techniques are well known to those skilled in the art to facilitate transfection of a nucleic acid into an eukaryotic cell. These methods include, for instance, treating the cells with high concentrations of salt such as a calcium or magnesium salt, an electric field, detergent, or liposome mediated transfection, to render the host cell competent for the uptake of the nucleic acid
25 molecules, and by such methods as micro-injection into a pro-nucleus, sperm-mediated and restriction-mediated integration.

The terms "recombinant cell" and "genetically transformed cell" refer to a cell comprising a combination of nucleic acid segments not found in a single cell with each other in nature. A new combination of nucleic acid segments can be introduced
30 into an organism using a wide array of nucleic acid manipulation techniques available to those skilled in the art. A recombinant cell can be a prokaryotic cell, or a

eukaryotic cell, such as, but not limited to, an avian cell. The recombinant cell may harbor a vector that is extragenomic, i.e. that does not covalently insert into the cellular genome, including a non-nuclear (e.g. mitochondrial) genome(s). A recombinant cell may further harbor a vector or a portion thereof that is intragenomic, i.e. covalently incorporated within the genome (including non-nuclear genome(s)) of the recombinant cell.

As used herein, a "transgenic avian" is any avian, as defined above, including the chicken, in which one or more of the cells of the avian contain heterologous nucleic acid introduced by manipulation, such as by transgenic techniques. The nucleic acid may be introduced into a cell, directly or indirectly, by introduction into a precursor of the cell by way of deliberate genetic manipulation, such as by microinjection or by infection with a recombinant virus. Genetic manipulation also includes classical cross-breeding, or *in vitro* fertilization. A recombinant DNA molecule may be integrated within a chromosome, or it may be extrachromosomally replicating DNA.

The terms "chimeric animal" or "mosaic animal" are used herein to refer to animals in which the recombinant gene is found, or in which the recombinant is expressed, in some but not all cells of the animal. The term "tissue-specific chimeric animal" indicates that the recombinant gene is present and/or expressed in some tissues but not others.

As used herein, the term "transgene" means a nucleic acid sequence that is partly or entirely heterologous, i.e., foreign, to the transgenic animal or cell into which it is introduced, or, is homologous to an endogenous gene of the transgenic animal or cell into which it is introduced, but which is designed to be inserted, or is inserted, into the animal's genome in such a way as to alter the genome of the cell into which it is inserted (e.g., it is inserted at a location which differs from that of the natural gene or its insertion results in a knockout).

The term "chromosomal positional effect" as used herein refers to the variation in the degree of gene transcription as a function of the location of the transcribed locus within the cell genome. Random transgenesis may result in a transgene being inserted at different locations in the genome so that individual cells

of a population of transgenic cells may each have at least one transgene, each at a different location and therefore each in a different genetic environment. Each cell, therefore, may express the transgene at a level specific for that particular cell and dependent upon the immediate genetic environment of the transgene. In a transgenic
5 animal, as a consequence, different tissues may exhibit different levels of transgene expression. The term "reduced chromosomal positioning effect" as used herein refers to a decreased intercellular variation in the level of gene transcription because of a reduction in the number of sites of insertion of a heterologous nucleic acid molecule into the genome of a recipient cell. Consequently, a reduced chromosomal
10 positioning effect provides a more uniform population of genetically transformed cells with respect to transgene insertion sites in the cellular genomes. In transgenic animals, different tissues may exhibit reduced variability in the levels of transgene expression.

The term "cytokine" as used herein refers to any secreted polypeptide that
15 affects a function of cells and modulates an interaction between cells in the immune, inflammatory or hematopoietic response. A cytokine includes, but is not limited to, monokines and lymphokines. Examples of cytokines include, but are not limited to, interferon α 2b, Interleukin-1 (IL-1), Interleukin-6 (IL-6), Interleukin-8 (IL-8), Tumor Necrosis Factor- α (TNF- α .) and Tumor Necrosis Factor β (TNF- β).

20 The term "antibody" as used herein refers to polyclonal and monoclonal antibodies and fragments thereof, and immunologic binding equivalents thereof. Antibodies may include, but are not limited to polyclonal antibodies, monoclonal antibodies (mAbs), humanized or chimeric antibodies, single chain antibodies, Fab fragments, F(ab')₂ fragments, fragments produced by a Fab expression library, anti-
25 idiotypic (anti-Id) antibodies, and epitope-binding fragments of any of the above.

The term "immunoglobulin polypeptide" as used herein refers to a constituent polypeptide of an antibody or a polypeptide derived therefrom. An "immunological polypeptide" may be, but is not limited to, an immunological heavy or light chain and may include a variable region, a diversity region, joining region and a constant region
30 or any combination, variant or truncated form thereof. The term "immunological polypeptides" further includes single-chain antibodies comprised of, but not limited

to, an immunoglobulin heavy chain variable region, an immunoglobulin light chain variable region and optionally a peptide linker.

Techniques useful for isolating and characterizing the nucleic acids and proteins of the present invention are well known to those of skill in the art and
5 standard molecular biology and biochemical manuals may be consulted to select suitable protocols without undue experimentation. See, for example, Sambrook *et al.*, 1989, "Molecular Cloning: A Laboratory Manual", 2nd ed., Cold Spring Harbor, the content of which is herein incorporated by reference in its entirety.

10 Abbreviations

Abbreviations used in the present specification include the following: aa, amino acid(s); bp, base pair(s); kb, kilobase; cDNA, DNA complementary to RNA; SSC, sodium chloride-sodium citrate; DMSO, dimethyl sulfoxide; MAR, matrix attachment region; CPE, chromosomal positioning effect; BAC, bacterial artificial
15 chromosome; YAC, yeast artificial chromosome.

The present invention provides novel isolated and recombinant nucleic acid molecules comprising an avian ovalbumin transcriptional regulatory region and at least one MAR element, which are useful as vectors for inserting a heterologous
20 nucleic acid molecule into the genome of a recipient avian cell. The novel isolated nucleic acid molecules of the present invention are particularly useful for directing the incorporation of a heterologous nucleic acid that is under transcriptional regulation of an avian ovalbumin gene promoter, into the genome of a recipient avian cell while reducing or avoiding chromosomal positioning effects that would otherwise
25 result from randomly distributed insertions of the heterologous nucleic acid molecule into the recipient avian genome. The present invention further provides methods of delivering a heterologous nucleic acid under the transcriptional regulation of an avian ovalbumin transcriptional regulatory region, to an avian cell, whereby the heterologous nucleic acid desired to be expressed under the associated avian
30 ovalbumin gene transcriptional regulatory element can be integrated into an avian cell genome. As well as providing recombinant nucleic acids, vectors and derivatives

thereof, the present invention provides transfected and transgenic avian cells and birds derived therefrom that are capable of producing a heterologous polypeptide in the serum or the white of a laid egg.

Nucleic acids comprising the chicken ovalbumin gene and 5' and 3' MAR elements

5 The novel isolated and recombinant nucleic acid molecules of the present invention comprise the chicken ovalbumin gene comprising transcriptional regulatory elements positioned 5' upstream of the ovalbumin-encoding region of the native chicken ovalbumin locus and which are necessary for the regulated expression of a downstream polypeptide-encoding nucleic acid, and at least one MAR element.

10 The inclusion of a MAR element, and preferably at least two MARs, in the same nucleic acid and flanking the ovalbumin gene region, may confer positional independence to a transfected gene operably linked to the ovalbumin transcriptional regulatory region. While not wishing to be bound by any one theory, it is believed that the 5' and 3' MARs of a transfected nucleic acid molecule of the present
15 invention restrict the number of possible transgene insertion sites within the genome of the recipient avian cell, thereby reducing chromosomal positioning effects upon transcription levels. Thus the isolated novel nucleic acid molecules of the present invention are useful for reducing the chromosomal positional effects exerted on heterologous transgene expression. The heterologous transgene will be operably
20 linked to the ovalbumin transcriptional regulatory region within a novel recombinant nucleic acid molecule transfected into a recipient avian cell. Included in the nucleic acid molecules of the present invention are a region of the avian genome encompassing a MAR upstream of the ovalbumin locus and cis-regulatory elements that may allow gene expression in a tissue-specific manner. The ovalbumin promoter
25 region of the novel nucleic acid molecules is especially useful for directing expression of an operably linked heterologous nucleic acid in a transfected avian cell such as an avian oviduct cell.

 Also within the scope of the present invention that nucleic acid molecules further comprising a region of the chicken ovalbumin locus that is 3' of the
30 ovalbumin-encoding region, or of a nucleic acid insert encoding a heterologous

present invention includes at least one nucleic acid sequence encoding a 3' MAR element which may cooperate with a 5' MAR to limit the number of sites of insertion into the genome of an avian cell of a transfected nucleic acid molecule. In either event, the directed insertion induced by one or more MARs can reduce or eliminate chromosomal positioning effects, resulting in a more uniform level of gene
5 expression of the heterologous nucleic acid insert in a population of genetically transformed cells.

(a) *Isolated nucleic acid encompassing the chicken ovalbumin gene*

One aspect of the present invention, therefore, is a nucleic acid molecule
10 isolated from the genome of a chicken and comprising a proximal ovalbumin promoter suitable for directing transcription of regulation of a transcript encoding ovalbumin, and 5' and 3' MAR elements flanking the ovalbumin gene region.

BACs 120 and 77 (ATCC Accession Nos. _____) containing overlapping regions of the chicken genome, were sequenced and compiled as the
15 contiguous sequence SEQ ID NO: 1. BAC 120 includes the sequence from nucleotide position 1 to position 157354 of SEQ ID NO: 1. The sequence of BAC 77 begins at nucleotide position 157355 of SEQ ID NO: 1 to position 195102. The nucleic sequence of the 195,102 bp chicken genomic region SEQ ID NO: 1 (GenBank Accession No. _____) is shown in Fig. 1. A schematic showing identifiable
20 domains within SEQ ID NO: 1 that have sequence identity or homology to known domain families or previously identified genes mainly identified using BLAST, GenScan and MARWIZ software is shown in Fig. 2. BAC 26, constructed as described in Example 1 below and containing the entire nucleic acid insert SEQ ID NO: 1 less about 11.5 kb at the extreme 5' end, was deposited with American Type
25 Culture Collection (ATCC), 10801 University Blvd., Manassas, VA 20110, as ATCC No. PTA-5548 on September 24, 2003, under the conditions set forth in the Budapest Treaty.

The nucleic acid molecule SEQ ID NO: 1 of the present invention has at least four MAR elements. One MAR element is 5' upstream of the ovalbumin gene,
30 between about nucleotide positions 41701 and 41900. MAR-like elements are also between nucleotide positions 56001-56201, 56501-56901, 58401-58701, 76251-

between nucleotide positions 56001-56201, 56501-56901, 58401-58701, 76251-76451 and 80151-80451. Another MAR element is between about 96401-96800. MAR elements located 3' downstream of the ovalbumin gene are at nucleotide positions about 144651-144850, about 150601-151600, about 156681-157181, about
5 157081-15781, about 163701-164100, about 186201-186590 and about 190101-190800 of SEQ ID NO: 1. The chicken ovalbumin gene ATG start codon is at nucleotide position 133372.

Also dispersed along the nucleic acid molecule represented by SEQ ID NO: 1 are other identifiable domains listed, for example, in Table 2 below, including several
10 serpin- or serpin-like encoding genes, cis transcription regulatory elements of both the serpin-like and ovalbumin genes, and at least two other, putatively functional genes, X and Z. Between the various domains, genes or other elements are stretches of nucleotides, the functions of which may serve to maintain the position and configuration of the elements relative to each other.

15 The isolated nucleic acids of the present invention and derivatives and truncated variants thereof may be incorporated into a vector, such as a bacterial or yeast artificial chromosome. The BAC cloning system (Shizuya et al, *Proc. Natl. Acad. Sci (U.S.A.)*, 89:8794:8797, (1992) has been developed to stably maintain large fragments of genomic DNA (100-300 kb) in *E. coli*. An exemplary BAC vector
20 consists of the pBeloBAC11 vector that has been described by Kim et al, *Genomics*, 34:213:218 (1996). Genomic DNA can be partially digested, for example, using enzymes that permit ligation into either the BamH I or Hind III sites in the vector. It is contemplated that any suitable restriction sites may be used that are useful for incorporating genomic DNA into a selected BAC vector. Flanking these cloning sites
25 are T7 and SP6 RNA polymerase transcription initiation sites that can be used to generate end probes by either RNA transcription or PCR methods. BAC DNA is purified from the host cell as a supercoiled circle. Converting these circular molecules into a linear form precedes both size determination and introduction of the BACs into recipient avian cells. A suitable cloning site may be flanked, for example,
30 by two Not I restriction sites, permitting cloned segments to be excised from the vector by Not I digestion. Alternatively, the BAC vector may be linearized by

treatment with the commercially available enzyme lambda terminase that leads to the cleavage at a cosN site. However, this cleavage method results in a full length BAC clone containing both the insert DNA and the BAC vector sequences.

One embodiment of the novel isolated nucleic acid molecules of the present invention, therefore, is an isolated chicken nucleic acid molecule encoding an ovalbumin transcriptional regulatory region and a 5' MAR. In one embodiment of the present invention, the novel isolated nucleic acid molecule further comprises a 3' MAR downstream of the ovalbumin gene. The isolated nucleic acid molecules of the present invention may also include nucleic acid elements such as, but not limited to, a transcription enhancer element, a negative regulator element, a hormone responsive element, an avian CR1 repeat element that together may constitute, in whole or in part, the ovalbumin transcriptional regulatory region, a proximal ovalbumin promoter and a signal peptide-encoding region. There are also stretches of nucleic acid between these constituent elements that organize the various elements into an ordered linear array. While the constituent elements of the ovalbumin transcriptional control region are preferably ordered as in sequence SEQ ID NO: 1, it is within the scope of the present invention for the cis-elements of the ovalbumin transcriptional regulatory region to be in any linear arrangement that will allow the formation of a transcript comprising the nucleotide sequence, or its complement, of a nucleic acid insert operably linked to the ovalbumin transcriptional regulatory region.

The novel isolated nucleic acid molecules of the present invention allow one skilled in the art to, for example, (a) make copies of those nucleic acid molecules by procedures such as, but not limited to, insertion into a cell for replication by the cell, by chemical synthesis or by procedures such as PCR or LCR, (b) obtain nucleic acid molecules which include at least a portion of such nucleic acid molecules, including full-length genes, full-length coding regions, transcriptional regulatory sequences, truncated coding regions and the like, (c) identify and obtain ovalbumin transcriptional regulatory region homologs found in other avian species such as, but not limited to, turkey, duck, goose, quail, pheasant, parrot, finch, ratites including ostrich, emu and cassowary and, (d) to obtain isolated nucleic acids capable of hybridizing to an avian ovalbumin transcriptional regulatory region nucleic acid and

of being used as a probe to detect the presence of nucleic acid-related sequences by complementation between the probe and the target nucleic acid.

Such nucleic acid homologs can be obtained in a variety of ways including using traditional cloning techniques to screen appropriate libraries, amplifying appropriate libraries or DNA using oligonucleotide primers derived from the novel
5 nucleic acid molecules of the present invention in a polymerase chain reaction or other amplification method, and screening public and/or private databases containing genetic sequences using nucleic acid sequences of the present invention to identify targets. Examples of preferred libraries to screen, or from which to amplify nucleic
10 acid molecules, include but are not limited to avian BAC libraries, genomic DNA libraries, and cDNA libraries. Similarly, preferred sequence databases useful for screening to identify sequences in other species homologous to chicken ovalbumin transcriptional regulatory region include, but are not limited to, GenBank and the mammalian Gene Index database of The Institute of Genomics Research (TIGR).

15 Nucleotides used to construct the nucleic acids of the present invention can be labeled to provide a signal as a means of detection, using conventional labeling technologies such as radioactive labels, fluorescent compounds, enzymes and chemiluminescent moieties. Methods useful in selecting appropriate labels and binding protocols for binding the labels to the synthetic nucleotides are well known to
20 those of skill in the art.

In one embodiment of the isolated nucleic acid molecule according to the present invention, the nucleic acid is isolated from a chicken.

In other embodiments of the isolated nucleic acid molecule according to the present invention, the nucleic acid molecule comprises a nucleotide sequence having
25 at least 80% identity, at least 95% identity or at least 99% identity to the nucleotide sequence according to SEQ ID NO: 1, or the complement thereof.

In other embodiments, the isolated nucleic acid molecule of the invention comprises the nucleotide sequence according to SEQ ID NO: 1 or has the nucleotide sequence according to SEQ ID NO: 1. In another embodiment, the isolated nucleic
30 acid molecule can be an allelic variant of SEQ ID NO: 1.

(b) *Fragments and Variants of SEQ ID NO: 1*

Fragments of the isolated nucleic acid molecules of the present invention also are within the scope of the present invention. As used herein, a fragment of a nucleic acid molecule refers to a nucleotide sequence having fewer nucleotides than the
5 nucleotide sequence SEQ ID NO: 1 but which includes a nucleic acid sequence of the ovalbumin transcriptional regulatory region able to direct and regulate transcription of a nucleic acid, and at least one MAR element.

The isolated nucleic acid molecule having the sequence SEQ ID NO: 1 may be reduced in size by truncating regions that do not affect the expression of a
10 heterologous nucleic acid placed under the transcriptional control of the ovalbumin transcription regulatory region. A truncated variant of the nucleic acid molecule of the present invention is understood to be any variant of SEQ ID NO: 1 less nucleotides at either the 5' and/or the 3' end of SEQ ID NO: 1. For example, it is contemplated that any of the nucleotides from positions 1- about 40500 may be
15 individually, in part, or in total, deleted from the variant nucleic acid molecule. Similarly, nucleotides from positions about 151700, 164200, 186690 or 190900 to 195101 of the nucleic acid molecule having sequence SEQ ID NO: 1 may be removed, retaining 1, 2, 3, 4 or more of the MAR or MAR-like elements respectively located 3' at the chicken ovalbumin gene. Useful truncated variants of SEQ ID NO:
20 1, therefore, include, but are not limited to, from base position about 41000 to about 191500, to about 187000, to about 164500, to about 152000, or to about 145500 and from base position about 96000 to about 191500, to about 187000, to about 164500, to about 152000 or to about 145500. Other useful truncated variants of SEQ ID NO:
25 1 include regions from nucleotide positions about 56000, about 58350, about 76200 and about 80000 to about 191500, to about 187000, to about 164500, to about 152000 or to about 145500.

Therefore, the invention encompasses nucleic acid molecules which do not include regions that do not contribute to the desired functionality of inserting a heterologous nucleic acid into an avian genome with reduced or no chromosomal
30 positioning effect. The region 5' upstream of the MAR located at nucleotide positions 41701-41900 of SEQ ID NO: 1, may be deleted to give a truncated variant of SEQ ID

NO: 1. For example, the approximately 11.5 kb region extending from nucleotide position 1 of SEQ ID NO: 1 not present in BAC 26 may be deleted. Likewise, it is contemplated that other regions of SEQ ID NO: 1 as listed in Table 2, such as encoding the serpin-like proteins, may be selectively deleted.

5 Recombinant nucleic acids

Another aspect of the present invention is recombinant nucleic acid molecules comprising at least one, and preferably at least two, avian MARs and an avian ovalbumin transcription regulatory region, including the proximal promoter thereof. The recombinant nucleic acid molecules of the present invention are particularly
10 useful for delivering a desired heterologous nucleic acid to a recipient avian cell while reducing chromosomal positional effects upon transcription from the integrated heterologous nucleic acid. It is contemplated that regions of SEQ ID NO: 1 may be omitted from the recombinant nucleic acid molecules of the present invention without substantially affecting the reduction in the CPE compared to a similar nucleic acid
15 molecule not including MAR elements. For example, one or more of the serpin-encoding regions of SEQ ID NO: 1 listed in Table 2, below, may not be included.

The present invention, therefore, provides recombinant nucleic acid molecules that comprise at least one avian MAR and an avian ovalbumin transcription regulatory region optionally operably linked in a linear array to a selected
20 heterologous or endogenous polypeptide-encoding nucleic acid insert, and which may express the nucleic acid insert when transfected to a suitable host cell, preferably an avian cell.

The nucleic acid insert, such as a heterologous nucleic acid can be operably linked 3' downstream of the ovalbumin proximal promoter and is thereby expressed
25 as an RNA transcript by a transfected recipient cell. The heterologous nucleic acid may be inserted into the recombinant nucleic acid of the present invention 3' downstream of a region encoding a peptide leader region so that a heterologous polypeptide encoded by the inserted nucleic acid may include this leader region. It is within the scope of the present invention for the recombinant nucleic acid to have the
30 nucleic acid insert encoding the desired polypeptide to be operably inserted into the ovalbumin coding region, or operably replacing the ovalbumin coding region in whole

or in part. The generation of BACs comprising a heterologous nucleic acid under the transcriptional control of the ovalbumin gene control region according to the present invention are described in Examples 2 and 3, below.

To increase the efficiency of expression of the heterologous nucleic acid insert, a polyadenylation signal region may be included at the 3' end of the inserted nucleic acid to allow the transcript directed by the novel ovalbumin transcriptional regulatory region to proceed beyond the nucleic acid insert encoding a selected polypeptide thereby providing a transcript further comprising a 3' untranslated region and a polyadenylated tail. Any suitable functional polyadenylation signal sequence may be linked to the 3' end of the nucleic acid insert including, for example, the SV40 polyadenylation signal sequence SEQ ID NO: 2 as shown in Fig. 4, bovine growth hormone adenylation sequence or the like. It is further anticipated that the recombinant nucleic acid molecules of the present invention may comprise the chicken ovalbumin 3' domain, or a variant thereof. The ovalbumin 3' domain may comprise the ovalbumin 3' untranslated region, an ovalbumin gene polyadenylation sequence and at least one of the 3' MAR elements identified downstream of the ovalbumin-encoding region of SEQ ID NO: 1. If the heterologous nucleic acid is inserted within the ovalbumin encoding region, and in-phase with the ovalbumin gene, the polyadenylation signal region of the ovalbumin gene may be used.

In one embodiment of the recombinant nucleic acid molecule according to the present invention, the recombinant nucleic acid molecule comprises the nucleotide sequence according to SEQ ID NO: 1, or the complement thereof.

Another aspect of the present invention is a recombinant DNA molecule comprising a MAR element and an avian ovalbumin transcriptional regulatory region. In one embodiment, the ovalbumin transcriptional regulatory region is operably linked in linear array to a nucleic acid insert encoding a polypeptide sought to be expressed, and a polyadenylation signal sequence optionally operably linked thereto. It is contemplated that when the recombinant nucleic acid molecule is to be delivered to a recipient avian cell for expression therein, the sequence of the inserted heterologous nucleic acid sequence may be modified so that the codons thereof are optimized for the codon usage of the recipient species as described below. In a

preferred embodiment, a MAR element is located 5' upstream of the ovalbumin transcriptional regulatory region. Suitable MAR elements, for example, are located at about nucleotide positions about 41701-41800 and about 96401-96800 of sequence SEQ ID NO: 1.

5 In one embodiment of the present invention, the recombinant nucleic acid molecule comprises the nucleotide sequence from nucleotides position about 40750 to 195101 of SEQ ID NO: 1. Various embodiments of the recombinant nucleic acid molecules of the present invention comprise a 5' MAR and/or a 3' MAR, and the ovalbumin transcriptional regulatory region. In one embodiment, the recombinant
10 nucleic acid further comprises a T gene. In others, the recombinant nucleic acid further comprises at least one nucleic acid region selected from the group consisting of the U serpin gene, a V serpin gene, an X gene, a Y gene and a Z serpin derived from SEQ ID NO: 1.

 Another embodiment of the recombinant nucleic acid molecules further
15 comprises at least one avian MAR 3' downstream of the nucleic acid insert. Suitable MAR elements for inclusion 3' downstream of the ovalbumin transcriptional regulatory region of the recombinant construct of the present invention are found at nucleotide positions about 144651-144850, about 150800-151600, about 163701-164100, about 186201-186590 and about 190101-190800 of sequence SEQ ID NO: 1.

20 In one embodiment of the recombinant nucleic acid molecules, the ovalbumin transcriptional regulatory region, the avian 5' MAR, and the avian 3' MAR are independently capable of hybridizing under high stringency conditions to the nucleic acid sequence according to SEQ ID NO: 1, or the complement thereof.

 In various embodiments of the present invention, the recombinant nucleic acid
25 molecule is inserted into a vector such as, but not limited to, a plasmid or viral vector.

 Other embodiments of the recombinant nucleic acid molecules further comprise a plasmid or viral origin of replication. In one embodiment, the recombinant nucleic acid molecule is a bacterial or yeast artificial chromosome.

 Yet another embodiment of the recombinant nucleic acid molecule according
30 to the present invention, therefore, is a recombinant nucleic acid molecule comprising an avian ovalbumin transcription regulatory region, an avian 5' MAR, a heterologous

nucleic acid encoding a heterologous polypeptide desired to be expressed by a recipient genetically modified cell, a polyadenylation signal sequence, and an avian 3' MAR, wherein the avian ovalbumin transcription regulatory region, 5' MAR, and the 3' MAR each independently hybridizes under high stringency conditions to the nucleic acid sequence SEQ ID NO: 1, or a complement thereof.

Polypeptide expression under the control of an avian ovalbumin promoter

Another aspect of the present invention of the novel isolated ovalbumin transcriptional regulatory region is increasing the amount of a heterologous protein present in a bird (especially the chicken) by gene transfer. Typically, a heterologous polypeptide-encoding nucleic acid insert transferred into the recipient animal host will be operably linked with the ovalbumin transcriptional regulatory region to allow the cell to initiate and continue production of the genetic product protein. A recombinant DNA molecule of the present invention can be transferred into the extra-chromosomal or genomic DNA of the host.

A useful application of the novel isolated and recombinant nucleic acid molecules of the present invention is to increase the amount of a heterologous protein present in a bird, (especially the chicken) by gene transfer. Typically, a heterologous polypeptide-encoding nucleic acid insert transferred into the recipient bird host or an isolated cell or cell-line from the bird will be operably linked with the ovalbumin transcriptional regulatory region to allow the cell to initiate and continue production of the genetic protein product.

The isolated nucleic acid molecule SEQ ID NO: 1 is useful for inserting therein a heterologous nucleic acid that is desired to be expressed as a transcript or, ultimately, as a polypeptide. A heterologous nucleic acid may be operably linked to the proximal promoter region of the ovalbumin gene at any position 3' downstream of the promoter that allows transcription from the heterologous nucleic acid and synthesis of the desired encoded peptide. Some, or all, of the ovalbumin-encoding region of the isolated or recombinant nucleic acids of the present invention may be replaced by a heterologous nucleic acid to be expressed under the transcriptional control of upstream ovalbumin gene control region. The heterologous nucleic acid may be inserted into the isolated or recombinant nucleic acids of the present invention

so that the expressed amino acid sequences derived from the ovalbumin may be linked to the expressed heterologous protein either at the N-terminus or C-terminus thereof.

Any of the vectors of the present invention may also optionally include a
5 sequence encoding a signal peptide that directs secretion of the protein expressed by the vector from the transgenic cells, for instance, from tubular gland cells of the oviduct. This aspect of the invention effectively broadens the spectrum of exogenous proteins that may be deposited in avian eggs using the methods of the invention. Where an exogenous protein would not otherwise be secreted, the vector bearing the
10 coding sequence is modified to comprise, for instance, about 60 bp encoding a signal peptide. The DNA sequence encoding the signal peptide is inserted in the vector such that the signal peptide is located at the N-terminus of the protein encoded by the vector.

The expression vectors of the present invention comprise avian ovalbumin
15 transcriptional regulatory regions that can direct expression of either fusion or non-fusion proteins. With fusion vectors, a number of amino acids are usually added to the desired expressed target gene sequence such as, but not limited to, a protein sequence for thioredoxin. A proteolytic cleavage site may further be introduced at a site between the target recombinant protein and the fusion sequence. Additionally, a
20 region of amino acids such as a polymeric histidine region may be introduced to allow binding of the fusion protein to metallic ions such as nickel bonded to a solid support, for purification of the fusion protein. Once the fusion protein has been purified, the cleavage site allows the target recombinant protein to be separated from the fusion sequence. Enzymes suitable for use in cleaving the proteolytic cleavage
25 site include, but are not limited to, Factor Xa and thrombin. Fusion expression vectors that may be useful in the present invention include pGex (Amrad Corp., Melbourne, Australia), pRIT5 (Pharmacia, Piscataway, NJ) and pMAL (New England Biolabs, Beverly, MA), that fuse glutathione S-transferase, protein A, or maltose E binding protein, respectively, to the target recombinant protein.

30 The present invention further relates to nucleic acid vectors and transgenes derived therefrom that incorporate polypeptide-encoding regions, wherein a first

polypeptide-encoding region is operatively linked to an avian ovalbumin promoter and a second polypeptide-encoding region is operatively linked to an Internal Ribosome Entry Sequence (IRES). It is contemplated that the first polypeptide-encoding region, the IRES and the second polypeptide-encoding region of a recombinant DNA of the present invention may be arranged linearly, with the IRES operably positioned immediately 5' of the second polypeptide-encoding region. This nucleic acid construct, when inserted into the genome of a bird and expressed therein, will generate individual polypeptides that may be post-translationally modified and combined in the white of a hard-shell bird egg. Alternatively, the expressed polypeptides may be isolated from an avian egg and combined *in vitro*.

Expression of a heterologous nucleic acid by a recombinant expression vector according to the present invention can be obtained using eukaryotic host cells, preferably avian cells, more preferably chicken cells, and still more preferably chicken oviduct cells, especially tubular gland cells. The use of eukaryotic host cells permit partial or complete post-translational modification such as, but not only, glycosylation and/or the formation of the relevant inter- or intra-chain disulfide bonds. Examples of vectors useful for expression in the chicken *Gallus gallus* include pYepSecI as in Baldari *et al.*, E.M.B.O.J., 6, 229-234 (1987) and pYES2 (Invitrogen Corp., San Diego, CA), incorporated herein by reference in their entireties.

One aspect of the present invention is methods of delivering a novel nucleic acid molecule of the present invention to the cytoplasm of an avian cell having a nucleus, thereby generating a transfected and genetically transformed avian cell. Such incorporation can be carried out by the various forms of transfection, depending upon the vector/host cell system. It is contemplated that the incorporation of recombinant nucleic acid molecules of the present invention into a recipient cell may be by any suitable method such as, but not limited to, viral transfer, electroporation, gene gun insertion, sperm-mediated transfer to an ovum, microinjection and the like.

In the various embodiments of these methods, the avian cell may be a chicken cell or a quail cell. In some embodiments of the methods of the present invention, the avian cell is within oviductal tissue of a bird, an isolated oviduct cell or primary cell

line, or a sustainable oviduct cell line. Preferably, the oviduct cells are tubular gland cells.

Heterologous polypeptide can be produced by transfected cells of the invention *in vitro*, i.e., in tissue culture outside the body of a living animal.
5 Alternatively, the nucleic acids of the present invention may be delivered to an animal such as a chicken, whereupon the nucleic acid may enter cells and be expressed therein. It is anticipated that the nucleic acids of the present invention may integrate into the genome of the recipient cells and then express the encoded, typically heterologous, polypeptide therein. Preferably, a heterologous nucleic acid is
10 delivered to oviduct cells within a chicken for synthesis of the desired polypeptide and its deposition in the white of an egg.

Another aspect of the present invention is a eukaryotic cell transfected with an expression vector according to the present invention and described above. For example, in one embodiment, the transformed cell can be a chicken oviduct cell or
15 cell line, including a sustainable cell line, and the transfected nucleic acid insert comprises the chicken ovalbumin transcriptional regulatory region, a 5' MAR and/or a 3' MAR, a nucleic acid insert encoding a human interferon $\alpha 2b$ and codon optimized for expression in an avian cell, and an SV40 polyadenylation sequence. In another example, the nucleic acid insert encodes an immunoglobulin heavy chain and a
20 second chain under the transcriptional control of an IRES.

The transfected cell according to the present invention may be transiently transfected, whereby the transfected recombinant nucleic acid, such as DNA, or expression vector may not be integrated into the genomic nucleic acid. However, the transfected recombinant DNA or expression vector may be stably integrated into the
25 genomic DNA of the recipient cell, thereby replicating with the cell so that each daughter cell receives a copy of the transfected nucleic acid. When the recombinant DNA or expression vector of the present invention is integrated into the genomic DNA of the recipient cell so that the cell is genetically transformed, it is anticipated that the MAR element(s) of the integrated nucleic acid will direct integration a
30 limited number of integration site within the target genome, thereby producing a

population of cells more uniform with regard to the level of expression of the heterologous nucleic acid.

The the present invention also includes a transgenic bird producing a heterologous protein expressed from a transfected nucleic acid according to the present invention. The transgenic bird is selected from a turkey, duck, goose, quail, pheasant, ratite, an ornamental bird or a feral bird. In a preferred embodiment, the avian is a chicken and the heterologous protein produced under the transcriptional control of the avian ovalbumin transcriptional regulatory region according to the present invention is produced in the white of an egg.

10 Viral host cell transformation

Nucleic acid sequences or derivative or truncated variants thereof, may be introduced into viruses such as an adenovirus or vaccinia virus. Methods for making a viral recombinant vector useful for expressing a protein under the control of the ovalbumin promoter are analogous to the methods disclosed in U.S. Patent Nos. 4,603,112; 4,769,330; 5,174,993; 5,505,941; 5,338,683; 5,494,807; 4,722,848; 15 Paoletti, E., 1996, *Proc. Natl. Acad. Sci.* 93: 11349-11353; Moss, 1996, *Proc. Natl. Acad. Sci.* 93: 11341-11348; Roizman, 1996, *Proc. Natl. Acad. Sci.* 93: 11307-11302; Frolov et al., 1996, *Proc. Natl. Acad. Sci.* 93: 11371-11377; Grunhaus et al., 1993, *Seminars in Virology* 3: 237-252 and U.S. Patent Nos. 5,591,639; 5,589,466; and 20 5,580,859 relating to DNA expression vectors, *inter alia*, the contents of which are incorporated herein by reference in their entireties.

Retrovirus vectors and adeno-associated virus vectors provide efficient systems of delivery of genes into cells, and the transferred nucleic acids may be stably integrated into the chromosomal DNA of the host. Protocols for producing recombinant retroviruses and for infecting cells *in vitro* or *in vivo* with such viruses 25 can be found in Ausubel et al., 1989, *Current Protocols in Molecular Biology* §§ 9.10-9.14 and other standard laboratory manuals. Examples of suitable retroviruses include pLJ, pZIP, pWE and pEM which are well known to those skilled in the art. Examples of suitable packaging virus lines for preparing both ecotropic and 30 amphotropic retroviral systems include psiCrip, psiCre, psi2 and psiAm.

Furthermore, it is possible to limit the infection spectrum of retroviruses and consequently of retroviral-based vectors, by modifying the viral packaging proteins on the surface of the viral particle (see, for example PCT publications WO 93/25234, WO 94/06920, and WO 94/11524). Roux et al., 1898, *Proc. Natl. Acad. Sci.* 86:9079-9083; Julan et al., 1992, *J. Gen. Virol.* 73:3251-3255; and Goud et al., 1983, *Virology* 163:251-254); Neda et al., 1991, *J. Biol. Chem.* 266:14143-14146), which are incorporated herein by reference in their entireties.

One retrovirus for randomly introducing a transgene into the avian genome is a replication-deficient ALV retrovirus. To produce an appropriate ALV retroviral vector, a pNLB vector may be modified by inserting a region comprising at least part of the ovalbumin transcriptional regulatory region, a MAR element and one or more exogenous genes between the 5' and 3' long terminal repeats (LTRs) of the retrovirus genome. Any coding sequence placed in-frame and downstream of the ovalbumin promoter will be expressed at high levels and especially in the tubular gland cells of the oviduct magnum because the ovalbumin promoter drives the high level of expression of the ovalbumin protein and is only active in the oviduct tubular gland cells.

Another viral gene delivery system useful in the present invention utilizes adenovirus-derived vectors (see, for example, Berkner et al., 1988, *BioTechniques* 6:616-629; Rosenfeld et al., 1991, *Science* 252:431-434; and Rosenfeld et al., 1992, *Cell* 68:143-155), incorporated herein by reference in their entireties. Suitable adenoviral vectors derived from the adenovirus strain Ad type 5 dl324 or other strains of adenovirus (e.g., Ad2, Ad3, Ad7 etc.) are well known to those skilled in the art. Introduced adenoviral DNA (and foreign DNA contained therein) is not integrated into the genome of a host cell but remains episomal, thereby avoiding potential problems that can occur as a result of insertional mutagenesis in situations where introduced DNA becomes integrated into the host genome (e.g., retroviral DNA).

Yet another viral vector system is the adeno-associated virus (AAV). Vectors containing as little as 300 base pairs of AAV can be packaged and can integrate. In the present invention, at least part of the heterologous nucleic acid will include an operable region of the avian ovalbumin transcriptional regulatory region and a MAR

element. An AAV vector such as that described in Tratschin et al., 1985, *Mol. Cell. Biol.* 5:3251-3260, can be used to introduce DNA into cells.

Other viral vector systems that may have application in the methods according to the present invention have been derived from, but are not limited to, herpes viruses,
5 vaccinia viruses, avian leucosis viruses and several RNA viruses.

Non-viral expression vectors

Most non-viral methods of gene transfer rely on normal mechanisms used by eukaryotic cells for the uptake and intracellular transport of macromolecules. In preferred embodiments, non-viral gene delivery systems of the present invention rely
10 on endocytic pathways for the uptake of the subject ovalbumin transcriptional regulatory region and operably linked polypeptide-encoding nucleic acid by the targeted cell. Exemplary gene delivery systems of this type include liposomal derived systems, poly-lysine conjugates, and artificial viral envelopes.

In a representative embodiment, a nucleic acid comprising the novel
15 recombinant nucleic acids of the present invention can be entrapped in liposomes bearing positive charges on their surface (e.g., lipofectins) and (optionally) which are tagged with antibodies against cell surface antigens of the target tissue (Mizuno et al., 1992, *NO Shinkei Geka* 20: 547-551; PCT publication WO91/06309; Japanese patent application 1047381; and European patent publication EP-A-43075, all of which are
20 incorporated herein by reference in their entireties).

In similar fashion, the gene delivery system comprises an antibody or cell surface ligand that is cross-linked with a gene binding agent such as polylysine (see, for example, PCT publications WO93/04701, WO92/22635, WO92/20316, WO92/19749, and WO92/06180, all of which are incorporated herein by reference in
25 their entireties). It will also be appreciated that effective delivery of the subject nucleic acid constructs via receptor-mediated endocytosis can be improved using agents which enhance escape of genes from the endosomal structures. For instance, whole adenovirus or fusogenic peptides of the influenza HA gene product can be used as part of the delivery system to induce efficient disruption of DNA-containing
30 endosomes (Mulligan et al., 1993, *Science* 260-926; Wagner et al., 1992, *Proc. Natl. Acad. Sci.* 89:7934-7938; and Christiano et al., 1993, *Proc. Natl. Acad. Sci.* 90:2122-

2126, all of which are incorporated herein by reference in their entireties). It is further contemplated that a recombinant DNA molecule of the present invention may be delivered to a recipient host cell by other non-viral methods including by gene gun, microinjection, sperm-mediated transfer, or the like.

5 Another aspect of the present invention is a method of expressing a heterologous polypeptide in a eukaryotic cell by transfecting a cell with a recombinant nucleic acid molecule of the invention, as described above, and culturing the transfected cell under conditions suitable for expression of the heterologous polypeptide under the control of the avian ovalbumin transcriptional regulatory
10 region.

In one embodiment of this aspect, the nucleic acid molecule is integrated into the genome of the recipient avian cell. In some embodiments the recipient avian oviduct cell is a chicken cell, preferably a chicken oviduct cell, more preferably an oviduct tubular gland cell.

15 The protein of the present invention may be produced in purified form by any known conventional techniques. For example, chicken cells, an egg or an egg white may be homogenized and centrifuged. The supernatant may then be subjected to sequential ammonium sulfate precipitation and heat treatment. The fraction containing the protein of the present invention is subjected to gel filtration in an
20 appropriately sized dextran or polyacrylamide column to separate the proteins. If necessary, the protein fraction may be further purified by HPLC or other methods well known in the art of protein purification.

Expression of heterologous multimeric proteins by transfected avian cells

The present invention provides methods for the production of a multimeric
25 protein by an avian cell, comprising the step of culturing an avian cell transfected with a first expression vector and, optionally, a second expression vector; the expression vectors may each have a transcription unit comprising a nucleotide sequence encoding a first heterologous polypeptide, a transcription promoter, and a transcriptional terminator operatively linked to the nucleotide sequence encoding a
30 second heterologous polypeptide, such that the cultured avian cell produces a multimeric protein comprising the first and second heterologous polypeptides.

The isolated nucleic acids and recombinant nucleic acid constructs derived therefrom of the present invention are useful to express nucleic acid sequences of polypeptides that are optimized for expression in avian cells, and derivatives and fragments thereof. Such derivatives include, for instance, polypeptides with conservative amino acid replacements, that is, those within a family of amino acids that are related in their side chains (commonly known as acidic, basic, nonpolar, and uncharged polar amino acids). Phenylalanine, tryptophan, and tyrosine are sometimes classified jointly as aromatic amino acids and other groupings are known in the art (see, for example, "Biochemistry", 2nd ed, L. Stryer, ed., WH Freeman and Co.,1981). Peptides in which more than one replacement has taken place can readily be tested for activity in the same manner as derivatives with a single replacement, using conventional polypeptide activity assays (e.g. for enzymatic or ligand binding activities).

Regarding codon optimization, for example, if the recombinant DNA is transfected into a recipient chicken cell, the sequence of the nucleic acid insert to be expressed is optimized for chicken codon usage. This may be determined from the codon usage of at least one, and preferably more than one, protein expressed in a chicken cell according to well known principles. For example, in the chicken the codon usage may be determined from the nucleic acid sequences encoding the proteins lysozyme, ovalbumin, ovomucin and ovotransferrin of chicken. Optimization of the sequence for codon usage elevates the level of translation in avian eggs.

One embodiment of the recombinant nucleic acid of the present invention, comprises an insert encodes the human interferon $\alpha 2b$ polypeptide. The exemplary nucleic acid sequence SEQ ID NO: 3 (Fig. 5) encodes the polypeptide human interferon $\alpha 2b$ in accordance with avian cell codon usage, as determined from the nucleotide sequences encoding chicken ovomucin, ovalbumin, ovotransferrin and lysozyme.

The invention methods for producing multimeric proteins include immunoglobulins, such as antibodies, and antigen binding fragments thereof. Thus, in one embodiment of the present invention, the multimeric protein is an

immunoglobulin, wherein the first and second heterologous polypeptides are an immunoglobulin heavy and light chains respectively. Illustrative examples of this and other aspects of the present invention for the production of heterologous multimeric polypeptides in avian cells are fully disclosed in U.S. Patent Application No. 5 09/877,374, filed June 8, 2001, by *Rapp*, published as US-2002-0108132-A1 on August 8, 2002, and U.S. Patent Application No. 10/251,364, filed September 18, 2002, by *Rapp*, both of which are incorporated herein by reference in their entirety.

Accordingly, the invention further provides immunoglobulin and other multimeric proteins that have been produced by transgenic avians of the invention.

10 In various embodiments, an immunoglobulin polypeptide encoded by the transcriptional unit of at least one expression vector may be an immunoglobulin heavy chain polypeptide comprising a variable region or a variant thereof, and may further comprise a D region, a J region, a C region, or a combination thereof. An immunoglobulin polypeptide encoded by an expression vector may also be an
15 immunoglobulin light chain polypeptide comprising a variable region or a variant thereof, and may further comprise a J region and a C region. The present invention also contemplates multiple immunoglobulin regions that are derived from the same animal species, or a mixture of species including, but not only, human, mouse, rat, rabbit and chicken. In preferred embodiments, the antibodies are human or
20 humanized.

In other embodiments, the immunoglobulin polypeptide encoded by at least one expression vector comprises an immunoglobulin heavy chain variable region, an immunoglobulin light chain variable region, and a linker peptide thereby forming a single-chain antibody capable of selectively binding an antigen.

25 Another aspect of the present invention provides a method for the production in an avian of an heterologous protein capable of forming an antibody suitable for selectively binding an antigen. This method comprises a step of producing a transgenic avian incorporating at least one transgene, wherein the transgene encodes at least one heterologous polypeptide selected from an immunoglobulin heavy chain
30 variable region, an immunoglobulin heavy chain comprising a variable region and a constant region, an immunoglobulin light chain variable region, an immunoglobulin

light chain comprising a variable region and a constant region, and a single-chain antibody comprising two peptide-linked immunoglobulin variable regions.

In one embodiment of this method, the isolated heterologous protein is an antibody capable of selectively binding to an antigen which may be generated by combining at least one immunoglobulin heavy chain variable region and at least one immunoglobulin light chain variable region, preferably cross-linked by at least one disulfide bridge. The combination of the two variable regions generates a binding site that binds an antigen using methods for antibody reconstitution that are well known in the art.

The present invention also encompasses immunoglobulin heavy and light chains, or variants or derivatives thereof, to be expressed in separate transgenic avians, and thereafter isolated from separate media including serum or eggs, each isolate comprising one or more distinct species of immunoglobulin polypeptide. The method may further comprise the step of combining a plurality of isolated heterologous immunoglobulin polypeptides, thereby producing an antibody capable of selectively binding to an antigen. In this embodiment, for instance, two or more individual transgenic avians may be generated wherein one transgenic produces serum or eggs having an immunoglobulin heavy chain variable region, or a polypeptide comprising such, expressed therein. A second transgenic animal, having a second transgene, produces serum or eggs having an immunoglobulin light chain variable region, or a polypeptide comprising such, expressed therein. The polypeptides from two or more transgenic animals may be isolated from their respective sera and eggs and combined in vitro to generate a binding site capable of binding an antigen.

Examples of therapeutic antibodies that can be used in methods of the invention include but are not limited to HERCEPTIN® (Trastuzumab) (Genentech, CA) which is a humanized anti-HER2 monoclonal antibody for the treatment of patients with metastatic breast cancer; REOPRO® (abciximab) (Centocor) which is an anti-glycoprotein IIb/IIIa receptor on the platelets for the prevention of clot formation; ZENAPAX® (daclizumab) (Roche Pharmaceuticals, Switzerland) which is an immunosuppressive, humanized anti-CD25 monoclonal antibody for the

prevention of acute renal allograft rejection; PANOREX™ which is a murine anti-I7-IA cell surface antigen IgG2a antibody (Glaxo Wellcome/Centocor); BEC2 which is a murine anti-idiotypic (GD3 epitope) IgG antibody (ImClone System); IMC-C225 which is a chimeric anti-EGFR IgG antibody (ImClone System); VITAXIN™ which is a humanized anti- α V β 3 integrin antibody (Applied Molecular Evolution/MedImmune); Campath 1H/LDP-03 which is a humanized anti CD52 IgG1 antibody (Leukosite); Smart M195 which is a humanized anti-CD33 IgG antibody (Protein Design Lab/Kanebo); RITUXAN™ which is a chimeric anti-CD20 IgG1 antibody (IDEC Pharm/Genentech, Roche/Zettyaku); LYMPHOCIDE™ which is a humanized anti-CD22 IgG antibody (Immunomedics); ICM3 is a humanized anti-ICAM3 antibody (ICOS Pharm); IDEC-114 is a primatized anti-CD80 antibody (IDEC Pharm/Mitsubishi); ZEVALIN™ is a radiolabelled murine anti-CD20 antibody (IDEC/Schering AG); IDEC-131 is a humanized anti-CD40L antibody (IDEC/Eisai); IDEC-151 is a primatized anti-CD4 antibody (IDEC); IDEC-152 is a primatized anti-CD23 antibody (IDEC/Seikagaku); SMART anti-CD3 is a humanized anti-CD3 IgG (Protein Design Lab); 5G1.1 is a humanized anti-complement factor 5 (CS) antibody (Alexion Pharm); D2E7 is a humanized anti-TNF- α antibody (CATIBASF); CDP870 is a humanized anti-TNF- α Fab fragment (Celltech); IDEC-151 is a primatized anti-CD4 IgG1 antibody (IDEC Pharm/SmithKline Beecham); MDX-CD4 is a human anti-CD4 IgG antibody (Medarex/Eisai/Genmab); CDP571 is a humanized anti-TNF- α IgG4 antibody (Celltech); LDP-02 is a humanized anti- α 4 β 7 antibody (LeukoSite/Genentech); OrthoClone OKT4A is a humanized anti-CD4 IgG antibody (Ortho Biotech); ANTOVA™ is a humanized anti-CD40L IgG antibody (Biogen); ANTEGREN™ is a humanized anti-VLA-4 IgG antibody (Elan); and CAT-152 is a human anti-TGF- β ₂ antibody (Cambridge Ab Tech).

Production of Exogenous Protein by Transgenic Avians

Methods for the production of heterologous protein by the avian oviduct and the production of eggs which contain heterologous protein involve providing a suitable vector and introducing the vector into embryonic blastodermal cells so that the vector can integrate into the avian genome. A subsequent step involves deriving a mature transgenic avian from the transgenic blastodermal cells produced in the

previous steps. Deriving a mature transgenic avian from the blastodermal cells optionally involves transferring the transgenic blastodermal cells to an embryo and allowing that embryo to develop fully, so that the cells become incorporated into the bird as the embryo is allowed to develop. Another alternative is to transfer the
5 transfected nucleus to an enucleated recipient cell which may then develop into a zygote and ultimately an adult bird. The resulting chick is then grown to maturity.

In an alternative embodiment, the cells of a blastodermal embryo are transfected or transduced with the vector directly within the embryo. It is contemplated, for example, that the recombinant nucleic acid molecules of the
10 present invention may also be introduced into a blastodermal embryo by direct microinjection of the DNA into a Stage X or earlier embryo that had been removed from the oviduct. The egg is then returned to the bird for shell development and laying. The resulting embryo is allowed to develop and the chick allowed to mature.

In either case, the transgenic bird so produced from the transgenic
15 blastodermal cells is known as a "founder" Some founders can be chimeric or mosaic birds if, for example, microinjection does not deliver nucleic acid molecules to all of the blastodermal cells of an embryo. Some founders will carry the transgene in the tubular gland cells in the magnum of their oviducts and will express the exogenous protein encoded by the transgene in their oviducts. If the exogenous protein contains
20 the appropriate signal sequences, it will be secreted into the lumen of the oviduct and onto the yolk of an egg.

Some founders are germ-line founders. A germ-line founder is a founder that carries the transgene in genetic material of its germ-line tissue, and may also carry the transgene in oviduct magnum tubular gland cells that express the exogenous protein.
25 Therefore, in accordance with the invention, the transgenic bird will have tubular gland cells expressing the exogenous protein and the offspring of the transgenic bird will also have oviduct magnum tubular gland cells that express the exogenous protein. (Alternatively, the offspring express a phenotype determined by expression of the exogenous gene in a specific tissue of the avian.)

30 The invention can be used to express, in large yields and at low cost, a wide range of desired proteins including those used as human and animal pharmaceuticals,

diagnostics, and livestock feed additives. Proteins such as growth hormones, cytokines, structural proteins and enzymes including human growth hormone, interferon, lysozyme, and β -casein are examples of proteins which are desirably expressed in the oviduct and deposited in eggs according to the invention. Other
5 possible proteins to be produced include, but are not limited to, albumin, α -1 antitrypsin, antithrombin III, collagen, factors VIII, IX, X (and the like), fibrinogen, hyaluronic acid, insulin, lactoferrin, protein C, erythropoietin (EPO), granulocyte colony-stimulating factor (G-CSF), granulocyte macrophage colony-stimulating factor (GM-CSF), tissue-type plasminogen activator (tPA), feed additive enzymes,
10 somatotropin, and chymotrypsin. Immunoglobulins and genetically engineered antibodies, including immunotoxins which bind to surface antigens on human tumor cells and destroy them, can also be expressed for use as pharmaceuticals or diagnostics.

One aspect of the present invention, therefore, concerns transgenic birds, such
15 as chickens, comprising a recombinant nucleic acid molecule of the present invention and which preferably (though optionally) express a heterologous gene in one or more cells in the animal. Suitable methods for the generation of transgenic avians having heterologous DNA incorporated therein are described, for example, in WO 99/19472 to Ivarie *et al.*; WO 00/11151 to Ivarie *et al.*; and WO 00/56932 to Harvey *et al.*, all
20 of which are incorporated herein by reference in their entirety.

In various embodiments of the transgenic bird of the present invention, the expression of the transgene may be restricted to specific subsets of cells, tissues or developmental stages utilizing, for example, *trans*-acting factors acting on the ovalbumin transcriptional regulatory region of the present invention and which
25 control gene expression in the desired pattern. Tissue-specific regulatory sequences and conditional regulatory sequences can be used to control expression of the transgene in certain spatial patterns. Moreover, temporal patterns of expression can be provided by, for example, conditional recombination systems or prokaryotic transcriptional regulatory sequences. The inclusion of a 5' MAR, and optionally a 3'
30 MAR region, in the novel nucleic acid molecules of the present invention will allow the heterologous expression unit to escape all, or in part, the chromosomal positional

effect and therefore be expressed at a more uniform level in transgenic tissues that received the transgene by a route other than through germ line cells.

In various embodiments of the present invention the transgenic avians comprise a recombinant nucleic acid comprising SEQ ID NO: 1, a truncated variant
5 of SEQ ID NO: 1, or the complement thereof.

In one embodiment of the present invention, the transgenic avian is selected from the group consisting of a chicken, a turkey, a duck, a goose, a quail, a pheasant, a ratite, an ornamental bird or a feral bird. In a preferred embodiment, the avian is a chicken.

10 In various embodiments, the transgenic avian produces the heterologous polypeptide in the serum or an egg white, or both.

The present invention is further illustrated by the following examples, which are provided by way of illustration and should not be construed as limiting. The
15 contents of all references, published patents and patents cited throughout the present application are hereby incorporated by reference in their entireties.

It will be apparent to those skilled in the art that various modifications, combinations, additions, deletions and variations can be made in the present invention
20 without departing from the scope or spirit of the invention. For instance, features illustrated or described as part of one embodiment can be used in another embodiment to yield a still further embodiment. It is intended that the present invention covers such modifications, combinations, additions, deletions and variations as come within the scope of the appended claims and their equivalents.

25

Example 1: Construction of a complete Ovalbumin locus from two overlapping BACs.

A complete ovalbumin locus BAC was created from two overlapping BACs that together contained the complete ovalbumin locus, as shown in Fig. 6. The
30 nucleotide sequences of BAC 120 and BAC 77 are in opposite directions with respect to the vector backbone pECBAC1.

monoclonal antibody and quantified with an alkaline phosphatase conjugated goat anti-human gamma detection antibody. Hen # AA698 expressed up to 1025 pg of human monoclonal antibody per ml of egg white.

5 **Example 3: Expression of a heterologous gene by a chicken ovalbumin locus**

BAC.

The open reading frame of the firefly luciferase gene was inserted into the ovalbumin translation start site of an ovalbumin locus BAC as shown in Fig 3. The luciferase gene was inserted into a plasmid that contained a 2.7 kb EcoR1 fragment
10 from the ovalbumin gene and which includes the ovalbumin start site. The resulting vector was then digested with EcoRI and cloned into an approximately 195kb ovalbumin BAC which had been subjected to EcoR1 recA-assisted restriction endonuclease (RARE) digestion as described by Boren et al., 1996, *Prot. Sci.* 5,: 2479-2484 and incorporated herein by reference in its entirety.

15 Primary tubular gland cells isolated from the oviduct of laying quail (Sanders and McKnight, *Endocrinology* 116, 398-405(1985)), were transfected using the ovalbumin-luciferase construct or with a negative control CMV-IFN construct. Luciferase activity in cell extracts was analyzed two days post transfection (Table 1).

Table 1

20

<u>DNA</u>	<u>RLU</u>
CMV-IFN	60
Ovalbumin Luciferase	274

Example 4: Basic Local Alignment Search Tool (BLAST) Analysis of the

25 **Complete Ovalbumin Promoter Sequence (SEQ ID NO: 1)**

The complete approximately 195kb ovalbumin promoter sequence (SEQ ID NO: 1) was submitted to the National Center for Biotechnology Information for BLAST alignments with database sequences. Further analysis was by using the GenScan and MARWIZ software. Percent identities between the ovalbumin gene
30 region sequence (SEQ ID NO: 1) and corresponding known ovalbumin promoter features are listed in Table 2 below.

Table 2:
Nucleotide positions of identifiable elements in the region of the chicken genomic
within BACs 120, 77 and 26

Nucleotide Positions^a	Domain Identity
5963-1	Q^b
9730-9922	CR1
10772-11935	CpG Island
18914-19088	CR1-GG
20106-20921	CR1-GG
39975-24820	R ATPase
41119-41177	CR1-GG
41586-41700	CR1-GG
41701-41800	MAR element
42221-42742	CpG Island
43505-46990	S Gene
50017-51427	T Gene
56001-56201	MAR-like element
56501-56901	MAR-like element
64599-71919	U Serpin Gene
58401-58701	MAR-like element
74883-75634	CR1-GG
75420-75634	CR1b
76251-76451	MAR-like element
80151-80451	MAR-like element
81125-94938	V Serpin Gene
81832-82120	CR1
85473-85922	CR1-GG
88654-88797	CR1-GG
90120-90167	CR1-GG
96401-96800	MAR element
97884-97965	Y:OV-1 element

99080-99107	SDRE element
100602-107839	X Gene
110247-111200	CR1-GG
114779-121099	Y Gene
117849-118132	CR1-GG
131729-139290	Ovalbumin
144651-144850	MAR element
147721-155849-	W Gene
150801- 151600	MAR element
156581-157181	MAR-like element
157081-157581	MAR-like element
157132-157331	MAR-like element
159095-165114	MENT
163701-164100	MAR element
171633-180432	Z1
183204-190418	Z2
186201-186590	MAR element
190101-190800	MAR element
192078-195101	Z3

^aNucleotide positions of protein encoding regions are from the beginning of the first exon to the end of the polyadenylation signal-exons are shown in Fig. 1

^bProtein coding regions are given in bold

5

Although preferred embodiments of the invention have been described using specific terms, devices, and methods, such description is for illustrative purposes only. The words used are words of description rather than of limitation. It is to be understood that changes and variations may be made by those of ordinary skill in the art without departing from the spirit or the scope of the present invention, which is set forth in the following claims. In addition, it should be understood that aspects of the various embodiments may be interchanged both in whole or in part.

10

What is Claimed Is:

1. An isolated nucleic acid molecule comprising an avian matrix attachment region and an avian ovalbumin transcriptional regulatory region.
2. The nucleic acid molecule according to Claim 1, further comprising a second
5 matrix attachment region.
3. The nucleic acid molecule according to Claim 1, comprising an avian 5' matrix attachment region and an avian 3' matrix attachment region.
4. The nucleic acid molecule according to Claim 1, wherein the nucleic acid molecule is isolated from a chicken cell.
- 10 5. The nucleic acid molecule according to Claim 1, comprising a nucleotide sequence having at least about 80% identity to the nucleotide sequence according to SEQ ID NO: 1, or the complement thereof.
6. The nucleic acid molecule according to Claim 1, comprising a nucleotide sequence having at least about 95% identity to the nucleotide sequence
15 according to SEQ ID NO: 1, or the complement thereof.
7. The nucleic acid molecule according to Claim 1, comprising a nucleotide sequence having at least about 99% identity to the nucleotide sequence according to SEQ ID NO: 1, or the complement thereof.
8. The nucleic acid molecule according to Claim 1, comprising the nucleotide
20 sequence according to SEQ ID NO: 1, or the complement thereof.
9. The nucleic acid molecule according to Claim 7, wherein the nucleic acid molecule consists of the nucleotide sequence according to SEQ ID NO: 1, or the complement thereof.

10. The nucleic acid molecule according to Claim 1, wherein the nucleic acid molecule is a truncated variant of SEQ ID NO: 1 comprising at least 103 kilobases of SEQ ID NO: 1.
- 5 11. The nucleic acid molecule according to Claim 1, wherein the nucleic acid molecule comprises a truncated variant of SEQ ID NO: 1 having a 5' end selected from the group consisting of the nucleotide positions about 41000, about 56000, about 58350, about 76200 and about 80000 of SEQ ID NO: 1, and having a 3' end selected from the nucleotide positions about 191500, about 187000, about 164500, about 157600, about 157100, about 152000 and
10 to about 145500 of SEQ ID NO: 1.
12. The nucleic acid molecule according to Claim 1, wherein the nucleic acid molecule comprises a truncated variant of SEQ ID NO: 1 and comprises the nucleic acid sequence from about nucleotide position 41500 to about position 195101 of SEQ ID NO: 1.
- 15 13. The nucleic acid molecule according to Claim 1, wherein the nucleic acid molecule comprises a truncated variant of SEQ ID NO: 1 and comprises the nucleic acid sequence from about nucleotide position 41500 to about position 187000 of SEQ ID NO: 1.
- 20 14. The nucleic acid molecule according to Claim 1, wherein the nucleic acid molecule comprises a truncated variant of SEQ ID NO: 1 and comprises the nucleic acid sequence from about nucleotide position 41500 to about position 164500 of SEQ ID NO: 1.
- 25 15. The nucleic acid molecule according to Claim 1, wherein the nucleic acid molecule comprises a truncated variant of SEQ ID NO: 1 and comprises the nucleic acid sequence from about nucleotide position 41500 to about position 152000 of SEQ ID NO: 1.

16. The nucleic acid molecule according to Claim 1, wherein the nucleic acid molecule comprises a truncated variant of SEQ ID NO: 1 and comprises the nucleic acid sequence from about nucleotide position 41500 to about position 145500 of SEQ ID NO: 1.
- 5 17. The nucleic acid molecule according to Claim 1, wherein the nucleic acid molecule comprises a truncated variant of SEQ ID NO: 1 and comprises the nucleic acid sequence from about nucleotide position 96000 to about position 195101 of SEQ ID NO: 1.
- 10 18. The nucleic acid molecule according to Claim 1, wherein the nucleic acid molecule comprises a truncated variant of SEQ ID NO: 1 and comprises the nucleic acid sequence from about nucleotide position 96000 to about position 191500 of SEQ ID NO: 1.
- 15 19. The nucleic acid molecule according to Claim 1, wherein the nucleic acid molecule comprises a truncated variant of SEQ ID NO: 1 and comprises the nucleic acid sequence from about nucleotide position 96000 to about position 187000 of SEQ ID NO: 1.
- 20 20. The nucleic acid molecule according to Claim 1, wherein the nucleic acid molecule comprises a truncated variant of SEQ ID NO: 1 and comprises the nucleic acid sequence from about nucleotide position 96000 to about position 164500 of SEQ ID NO: 1.
21. The nucleic acid molecule according to Claim 1, wherein the nucleic acid molecule comprises a truncated variant of SEQ ID NO: 1 and comprises the nucleic acid sequence from about nucleotide position 96000 to about position 152000 of SEQ ID NO: 1.
- 25 22. The nucleic acid molecule according to Claim 1, wherein the nucleic acid molecule comprises a truncated variant of SEQ ID NO: 1 and comprises the

nucleic acid sequence from about nucleotide position 96000 to about position 145500 of SEQ ID NO: 1.

23. A vector having inserted therein a nucleic acid molecule according to Claim 1.
24. The vector according to Claim 23 selected from the group consisting of an artificial chromosome, a plasmid vector and a viral vector.
25. A liposome composition comprising a nucleic acid molecule according to Claim 1.
26. The nucleic acid molecule according to Claim 1, wherein the nucleic acid molecule is a recombinant nucleic acid molecule.
27. The recombinant nucleic acid molecule according to Claim 26, wherein the ovalbumin transcriptional regulatory region and the matrix attachment region are independently capable of hybridizing under high stringency conditions to the nucleic acid sequence according to SEQ ID NO: 1, or the complement thereof.
28. The recombinant nucleic acid molecule according to Claim 26, further comprising a second matrix attachment region independently capable of hybridizing under high stringency conditions to the nucleic acid sequence according to SEQ ID NO: 1, or the complement thereof.
29. The recombinant nucleic acid molecule according to Claim 26, further comprising a heterologous nucleic acid sequence operably linked to the ovalbumin transcriptional regulatory region.
30. The recombinant nucleic acid molecule according to Claim 26, further comprising a endogenous nucleic acid sequence operably linked to the ovalbumin transcriptional regulatory region.

31. The recombinant nucleic acid molecule according to Claim 26, wherein the ovalbumin transcriptional regulatory region is capable of tissue-specific transcription by an avian oviduct cell.
32. The recombinant nucleic acid molecule according to Claim 26, further comprising an Internal Ribosome Entry Site.
33. The recombinant nucleic acid molecule according to Claim 32, further comprising a second heterologous nucleic acid sequence operably linked to the Internal Ribosome Entry Site.
34. A vector having inserted therein a recombinant nucleic acid molecule according to Claim 26,
35. The vector according to Claim 34 selected from the group consisting of a bacterial artificial chromosome, a yeast artificial chromosome, a plasmid vector and a viral vector.
36. The recombinant nucleic acid molecule according to Claim 26, further comprising a polyadenylation signal sequence.
37. The recombinant nucleic acid molecule according to Claim 29, wherein the heterologous nucleic acid sequence encodes a polypeptide having a codon complement optimized for protein expression in an avian.
38. The recombinant nucleic acid molecule according to Claim 26 further comprising an origin of replication selected from the group consisting of a bacterial origin of replication and a viral origin of replication.
39. The recombinant nucleic acid molecule according to Claim 26 which is a bacterial artificial chromosome.

40. A recombinant nucleic acid molecule comprising:
- (a) an avian ovalbumin transcriptional regulatory region;
 - (b) an avian 5' matrix attachment region;
 - (c) a heterologous nucleic acid encoding a polypeptide;
 - 5 (d) a polyadenylation signal sequence; and
 - (e) an avian 3' matrix attachment region,
- wherein the avian ovalbumin transcriptional regulatory control region, the 5' avian matrix attachment region, and the avian 3' matrix attachment region each hybridize under high stringency conditions to the nucleic acid sequence
- 10 SEQ ID NO: 1, or the complement thereof.
41. The recombinant nucleic acid molecule according to Claim 40, further comprising an Internal Ribosome Entry Site.
42. A method of generating a genetically transformed avian cell, comprising delivering a nucleic acid molecule according to Claim 1 to the avian cell
- 15 under conditions whereby a genetically transformed avian cell is generated.
43. The method according to Claim 42, wherein the nucleic acid molecule enters the nucleus of the avian cell
44. The method according to Claim 42, wherein the nucleic acid molecule integrates into the nuclear genome of the avian cell.
- 20 45. The method according to Claim 42, wherein the nucleic acid molecule is integrated into the nuclear genome such that it is subject to a reduced chromosomal positioning effect compared to an integrated molecule not having a matrix attachment region element.
46. The method according to Claim 42, wherein the avian cell is selected from a
- 25 chicken cell and a quail cell.

47. The method according to Claim 42, wherein the avian cell is an oviduct cell.
48. The method according to Claim 45, wherein the oviduct cell is a tubular gland cell.
49. The method according to Claim 42, wherein the avian cell is a cultured avian cell.
50. A method of expressing a heterologous polypeptide in an avian cell, comprising the steps of:
- (a) delivering a nucleic acid molecule according to Claim 29 to a recipient avian cell under conditions that generate a genetically transformed avian cell; and
 - (b) culturing the genetically transformed avian cell under conditions that produce expression of a heterologous polypeptide under the control of the avian ovalbumin transcription regulatory region.
51. The method according to Claim 50, wherein the nucleic acid molecule is integrated into the nuclear genome of the recipient avian cell.
52. The method according to Claim 50, wherein the recipient avian cell is a chicken cell.
53. The method according to Claim 50, wherein the recipient avian cell is an oviduct cell.
54. The method according to Claim 50, wherein the recipient avian cell is an oviductal tubular gland cell.
55. An avian cell, or the progeny thereof, comprising a nucleic acid molecule according to Claim 26.

56. The avian cell according to Claim 55, wherein the avian cell, or the progeny thereof, expresses the heterologous polypeptide encoded by the nucleic acid molecule.
57. The avian cell according to Claim 55, wherein the avian cell is selected from a chicken cell and a quail cell.
58. The avian cell according to Claim 55, wherein the avian cell is a chicken cell.
59. The avian cell according to Claim 55, wherein the avian cell is an oviduct cell.
60. The avian cell according to Claim 59, wherein the avian cell is an oviductal tubular gland cell cell.
61. The avian cell according to Claim 55, wherein the avian cell is a cultured cell.
62. A transgenic avian individual comprising a nucleic acid according to Claim 26.
63. The transgenic avian individual according to Claim 62, wherein the avian individual is selected from the group consisting of a chicken, a turkey, a duck, a goose, a quail, a pheasant, a ratite, an ornamental bird or a feral bird.
64. The transgenic avian individual according to Claim 62 which is a chicken.
65. The transgenic avian individual according to Claim 62 which produces the heterologous polypeptide in serum or egg white.
66. The transgenic avian individual according to Claim 65 which produces the heterologous polypeptide in egg white.
67. An avian egg wherein the egg white comprises a heterologous polypeptide expressed from a recombinant nucleic acid molecule according to Claim 29.

68. The egg white of an avian egg of Claim 67.
69. A heterologous polypeptide obtained from an egg of Claim 67.
70. A heterologous polypeptide obtained from an egg of Claim 50.

SEQ ID NO: 1

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24501 CAAAGCACTG GCTCATAACG TCTTCTCCTC ACAGTGTTTT CTTCCCTTACT
24551 TTCACAGCAA ACACACACAG TATGCTCAAT TAGCAAATTT TGTGTCATTT
24601 CTCTAAACGG AGTGATTAAC ACATAGGCTG ACTGCTACTG AAAACACCTG
24651 ACAAATCGCT TCTCTTGAC CCAAAAAA GGGTTTCTTT TTGAGCCTAC
24701 CAGAAAGTTGA AAACCCGCTT GCGCCAGGT CTAATATAAC AGCTAAAAC
24751 GATCATTTAA AAATTACAAA TATTTACCAT GAGTTGCCAC ATCACTCTGC
24801 TAAAAATTGTG TTTTCCGTAT TATTTTCCAA TAGAAGACAT TTAATAGACA
24851 TCTGAAGAAA ACAATACAAT ATAAAAGCGT AAGGGTCTTT GCAAAACAGAT
24901 CTTCTATTCC TTCTGCAAAG TAAGAAAGGA GAGAGTTTAT TGGCATTTAT
24951 TTGCAGTGCC ATCGATAAAG ACACGAGAAT ACTTAAGAAA GCAAAAAGTT

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R gene exon 9

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25001 CTAGTGATCC ACAGACATCT TTGGCTTAGC CTTCTGACC AAAGTCTTCT
25051 GTAAACTTCT TTAACTTCTC CAGGTCCTGC TCATTAACTG TTGGCTTTGT
25101 GCTAGCTAGC GACCTGAGCA TATCGGCCTG TGAGAAAGAA AGCAAGAAAA
25151 CATGCATTCA GAAAACGTAC CGCTGCTAAC AGTATTGCTG TGAAGAAAAG
25201 TAAGCTTTGA AAAGCCTTTT AAAACAAGTT GACTGTAGGA ACTCTTATTG
25251 AAACAAAAC TCGAGTAAGC CTGAACATTT CTGCACGTGG ACCACTTTTT
25301 AACCTCCTGA CGATAGACAA TTAGTGAGTT TTTACAGGAC TTAAGCCACA
25351 ATCTGAGGTT CAGCTTTAAA ACAATTCATC CATTCACAA GTGTTATCTA
25401 CCACTGCTTA CTGCAACAAA CTGAGCTTCC CATCTTACAG ATTCGTATTC
25451 CAATTCACTT TTAAGGACAT CAGGTTGAAG TGGAAAACCA TCACACGTTT
25501 CCACATATTC CAATGCCCAC CAACACAGAA TACTTCATCA TTGATCTCCA
25551 GCAAAGTTTT ACTGCTCATG ACTGCTAACT TCTGTTTCTT CAGCTCAGTC
25601 AGTTTTGTAT ATTTACATTT GGCTACTAGA AAATGGAGTT CAGAAAAAAA
25651 AACCACAGAG GTATGAACTC AAATTCAGCA GTTAAGAAAC CTTATTAAAA
25701 AAAAACGTAT ATAAAAAGTC CTGGCCAAAG GCAAAGCGAG GAGCTGCTCA
25751 ACACCTCACG TTAATAAAA AGCACAGGGT TAAGTTAAAG TCAGCATCAT
25801 GATTTTCTAG GCTTTCTCAT CTCATCGTAC TACAGACATC CTACTTAGAA
25851 AGAATTCAAG TCTGATCTTT TTAATGACAA GAACTGATTC TGGACTCTGA
25901 AATAAGTCCC TGTGCAACTG TAGCACATCA GAGTCTACCT TCCATTAGAA
25951 GCACTGAAGG AATTGTATTT AATTCAGGA AAGACTGATG AAAAATCCAC
26001 TTAGTTTACA CAGGCAGAAG TTTTAAGGCA GGCTGCACT TGCTTGCAATC
26051 TTTTCATGCC TCCTCCATGT GCAAATATGC AGATATTTCT CTCCTCAAAAC
26101 TAGTGATGGT TACATGTGCA AAGCAGTGCA CTCTACTTTA GAGGGTTTTT
26151 GATCCCTATG CAACACACCT TCCTTTCATT CATTACAGAA ACGTTTGCAC
26201 ACAGGAATGG CCATCAGCAC AGATCTGATA TCGAGTCCTT CTTTCAGACA
26251 ATGCAATTAC ATTCAGAAC TTTTGCTGCT TGAGGGTAAA ATATACGAGT
26301 GCTCAATGAT TTGTAACCTT TTAAACAATG TATTTAAACT TCAATTTCTC
26351 TCAAATATGA TGTTTTGGTC TGTAACAGAA AGCAAATATT TTAACATATA

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26401 CAAAAAATTC CAGCTGAATG TTAGCAAGAG CTGGCTGCAT CATCTGTGAT
 26451 GAAGTATAAT CCAAACTACC ATTGCATCCA CCAGCTTTTT ACATTGCATT
 26501 GGTATGCTT GCATTTCTTT TGTGGGCAAA ATTTACCTAC AGCATGTTAT
 26551 TCCCAGTTTA CACTGAATAT AATTTCCAC TTCTCGATGT CAATAATAAT
 26601 GCTACAGAGC AACAGGAAAG TAACATATCG TGGGGCAGGG ATTCTGAAGG
 26651 TTTTAAATGA ATAAAAGAAA AATTAAAGAA GGGAGGAAGA TTCAGGTGCT
 26701 GTCTATACTG CATGCCACTA GACAATAATA AATGCTTATC AGGGATGGAG
 26751 AGCTGGCTCG CTGATAAGCA TGTGTATTG TCATGCTGTG TGTGCGATT
 26801 AAAATGTCAT CCAGTATGTC CAAGCATGTC TAAAAACAAA GGGCTCAGCC
 26851 AATTGCCTTG CATGCTGGCT CTAAATGTC TTGAGTATTT TCAGGGTTCT
 26901 GCAAAGCAAG AAACACCACC AAAAAATAAA AAAATAAAAA CAAATACCCA

R gene exon 8

26951 CCATGGAAAC TTTAGGCTCC AGTAATTTAT CCCCTGGAAC ATCCATCCAT
 27001 GTCATTTCTT CAGCTTCAGG ATCACCCTGGA GAGCAAGGAG TGAACAAATC
 27051 TACCATGATA TTTGGATTCT TCACTGATGG TCCTTTTACC TAATAAATGA
 27101 ATACATAAAT AAATAAAATA AACAACTGA AGCTGAACAT CTTTAGAGCA
 27151 AAAGCATACT CTTAATTTTC TGTACATGCC CCACCCGTTT GGAGTTGTGT
 27201 AGTGAAAGTG AATTGTGTAA AGGTGCTGGC ATCGTTCACT TTGAAAACGC
 27251 ACAGCAGTAG TCAGATACTT GAACTCATA CAGTTCAGAA CCAATGAGCC
 27301 TTTAAGGTAG GAATGCTTGT AGAAAGCTAA TGTGCCAGGT CTACTGTTTG
 27351 GAGAAGACCA CTCTCTTCTT AGTCCTCAGT CACTTTGGGA GTCCATTAC
 27401 CACTGGTTAA CATTTCTAAA AAATTCTCAG TAGTTATTAC TGACTGACCC
 27451 TCAAGTTGGG CTGCCATGGG TGTCTTTTA AGCTTCCACT CACTGCACTA
 27501 AAAAGTTCCG GGCACCTFTT CTGACACAAT CTCTAACAGC ACTTGATAGA
 27551 AGATGGGGCC ATCTAGTGGA GGAACAGAAA CCATCCCTTC TTCCAGATAC
 27601 ATAGACAGAA CCTGAAAAGC TCCATCAGCT GCCTCTTATC TTTTGTCAAT
 27651 GCATATCTCA GACCTGTAGT TCTACCATCC TTCCTTTGTC AGTCACTGAA
 27701 GTATCACACA TCCCCATGAA CACGAAACAC ATGCAAAGGC GAAAAAGAA
 27751 CTGCTTTTAA CAGCAGAGAA CTGGATTGTC TGTTTCAATC TGCTTTTAAA
 27801 GCACAGCGAA GAAAAGCATG GATTATAATA CTGGAAACTC AACTTGGACA
 27851 AACCGCTATC AATAGGCTGG AACAAGCAAT GGGTTACAGT GAGTTACAGA

CRL-GG

27901 AATTGAGCAA AACGCTACAA ACAGGAGGCA GGGGCAGATG GCGATTGGGA
 27951 CAAGGGGGAA TAGTTTAAAC CAACAGAGGG GAGATGTAGG TGAGATGTTA
 28001 GGAGGAAACT TCTTACTCAG AGGGCAGAGA GCGCTGGCA CAGCTGCCCA
 28051 GAGAAGCTGT GGTGCCCCAT CCCTGGAGGC GCCCAAGGCC AGGTTGGATG
 28101 GGGCCCCAGG CAGCCTCAGC TGGTGGGGGG CAGCCCTCAC CATGGCATGG
 28151 GGTGAGGCT GGGTGGGCTT TGAGGTCCCT TCCAACCCCC AACCATCCCCA
 28201 TGATTCTATT TAACTGGGAC AAATGCTAC TATGGAAATA GTTAATAAAG
 28251 CAAAGGTTTT TCTTATAAAA ATAAGAATCT GCATCCAATT AAAGCACAAA
 28301 CAAAACAAGT GGAATAGACT TGCATCAGAA CACTCAAAGC ACGGTAGGCT
 28351 TTTTTCCTT TTTGGCAAAA GAGGTAAGAA TTGCCTTTGG CTGCTCTGCA
 28401 AACTGTGGTA ACTGAGATTA TTTCATTGTT CTGTGGCAGG CTGAGGCACG
 28451 CCTCAGATGT CTGCAAATTT CAATGAAAGG CTAAAAATGTG ACAACCCATT
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 28551 GCATCACTGC TTAAGGGAAG GAATAACCCA GAAAATCCCT GATATATCAA
 28601 AATAGCCGCT TATTTTAA GCAAATACAG TTTACAACAG CTCAAAATAC
 28651 TGTTTCAAAA TGTTCTTTGA TTTTAAACTG GGAAAAGTTC ATCAAAATAC
 28701 CTACCAATA TTCTTCCTCA CCACCAAAAT TACAGACTGC TGGCGTATTT
 28751 TAACAAGTTG ATAAGGCTTC CTCCTGCAA GCACTGGAAC TTAAACAGAT
 28801 CTCTTACATT CTGAACCATA TTGTATTAA GCGTTCCTTT CCCTTGGTGT
 28851 CTTAAGCTGA ATGTGTTCTT TACAATTACA TGGAGAAAAG TGCCACCTT
 28901 CAGTTCACAC TGAATCTAGC GTTTCAGCTG AGGGCTCTGG ATGAGTTACT
 28951 GGTAAAAAAC TAAGAACTG TCATCATAAC TCATGAGCAA CAACTGCTGC

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29001	CAACACAAGT	TGCGTGTATG	ACACGCAGAG	CAATAAAATG	AAAGCTCTGA
29051	AAGCTTCCCT	TTCCAGAGTC	AAAAGTCCCT	GCAGATAACA	AGAATCCACC
29101	TTCACCTGAA	GTTTGTGAAT	TTCTGTGAAA	ACAAAGTCTG	CAGTACAAAT
29151	GTAAACAGAT	TATTTTAGTT	TCGCTCTCTA	AAACCAAAAC	AACAGCAAGA
29201	AAAAACTAGA	CAAGAAAAAT	ACTATCATGT	TATTTATAAA	ATGTAGGCCGA
29251	AACTCCAAGA	TAAGCAAAAA	AAAAAAAGTC	TTATCTATCT	ATAGTTACAC
29301	TCTTTT TAGA	CATCAACTAA	GTGTAAAGTA	GTTTTCACCT	TACAGCAGCA
29351	TCCATAAGAT	GTTCCCTTGCT	GCCCCAGCAA	TGACAACGAC	CTTACTCAGC
29401	CGTCTTG CAT	CTTAACTACT	GTGACAAGTA	ACATTAGGGG	ATTCAATTTT
29451	TTACTGGAAT	CTTAGGATAA	TCTTAATTTT	ACAGTTTGAA	GGACATCCTG
29501	AGCAACAGT	TGTGCAGTTG	TAATTCCTCT	GTTCCACGCT	AGATAAGGAA
29551	TACGTTTATT	TACACACATG	CGCTAGAAAA	ACAATTACGT	AATTTGATAT
29601	AGAAGAAGAG	CACCACTGTA	AGACTCCGAT	TTAAGTTGAA	CTCCAAACCG
29651	AATGCTTTTA	ACAGCAGTTA	TAGACGTGAA	GATTGATTAG	AGCTTGGATT
29701	ACACAACATG	AATACCTAGA	GATGAGGTGC	ATCAACTTAT	GGCAGGAGTA
29751	CTCCTTTGGT	AGGTAATGAA	GAACAGCATA	CACACATCTG	TAAGCACACG
29801	GTATTACCCC	AAACCGAACT	TGGCTTACTT	ACAACAAGTT	TTCAGATCAA
29851	GTTAATTCTC	AGAGTTGAAG	CAATATGAAA	AACGTTTGTG	TTTTACTTAC

R gene exon 7

29901	TTTTTTAAAG	TGAGTAGCTG	ATTGCACTTT	TCTAACAGGT	TGCATCAGTG
29951	CATCGCGTAC	AATGATGCTT	ATATCTGCAC	CAGAATAGCC	ATCGGTTCTT
30001	TTCCCAAGCT	CCCGATAATC	TGCTTCTGTT	AGGAGATTGG	GAGTCGACCC
30051	GAGGTGAAGT	TTGAACATGG	CAGCCCTGGC	ATGGTCTTCA	GGTAAAGGAA
30101	TATAAATTCG	CTTCTCAAAC	CTGGTTTCCA	AAAGATAAAA	GCACTGGCTC
30151	ACGCAGGTGC	ACGATGGAAA	GAAGTTTATG	CAAATCAGTA	TATACTTTGT
30201	TTGTAAATGA	AACTGCTTTT	TTCTTATGTA	TTATAAATGT	TTAAAAATAT
30251	ATATCTCAGA	TATTCTGCAG	CCTGTTCTCA	TAAGTAATAC	CATGGCTATC
30301	ATAAGCTAAC	ATCTACAATT	TAACAACGAC	TTCTTTT TTA	TGACAGAAAG
30351	TCTCTTCAGA	CTGTAGTTTC	TCCAGGTTCA	CTCCAGAGAA	GTTTGT TTTTA
30401	AAAGAAAATA	ACTGAAGGAA	AAGGAGTCTT	TTAGTT TTTTA	AGTACATCTG
30451	AACAGTTTTC	ATAGAATCTT	AGAATCGCTA	AGGTTGGAAA	AGACCCACAG

CR1-L

30501	GATCATCCAG	TCCAAC TATT	CACCCATCGC	CAACGGTTCT	CACTAAACCA
30551	TGTCCCTCAA	CACAACATCC	AAACATTCCCT	TGAACACCTC	CAGGCTCGGT
30601	GACTCCACCA	CCTCTCTGGG	CAGCCCATTC	CAGTGCCCTGA	TCACTCTTTC
30651	AGAGAAATAG	TAGTGGTTTT	TCACACTCAA	AGAAAGAGCT	GCCCGATAAC
30701	ACGTTACACAC	AACCAGTTTC	TAAAGTTTGT	AAGTAGAGAA	CGTTGTAGTT
30751	GGAAACGAAT	TTGAAGTCTT	ACTCTCAATA	TAGTTGTTGG	TAGGAATGGT
30801	TGATACTTGC	GGTGCTTCCT	TTGAAGCATC	TGTTCTCAAA	GAGAGGACGA
30851	CCTCCCATCA	GGGAAATAGG	ACCGACTCCA	AGTTCTGTAG	AACACTATTA
30901	ACTTCCATATA	GGTAAGTGGG	CCCAAGCCAT	GAAAAATTAA	TTCTGTTACT
30951	GCCACGCTCT	ACAAGCTCCT	TTAAGTTTTT	CGGACAAGAA	TGAGAGATAC
31001	TCGTTACACAC	TGCAAAGAAT	GACTTGAAAT	GTTAAGTACC	ACATTCGCCT
31051	CTTATTCCTT	GTATGAAACT	ACACATGCAC	AGGATGGAAG	CGACCTCTGG
31101	AGGCCACATG	GTTTAAACTC	CCCAGTCAAA	GCACGGTCGA	GTTGAATTAA
31151	GTACATCGAT	AAAATGACAC	TGTCACCAAA	AAGGATTGTT	TCTTTAGCCT
31201	ACAAAAATTA	CCATTATACA	GGTTGTATCA	TCATCACAAC	ATAATCACAT
31251	TTGTCACGTA	ACTGTGTTTG	TCCTTTGCTG	CTCTGCAACT	GAAAGATCCA
31301	GCTAATCAGA	TACAGATACA	AACGTCATCC	CATTAGAGAA	AGGCAGTTGA
31351	AACGTACACT	GAAAGATCAC	ACAAACTGTG	TGACCAGTAC	AGCAAAAACA
31401	ATGCTTCTGC	ATTACTTAAA	TTCTGTGAAA	TTACTCAAGC	TATCCAAGGG
31451	TTTGCTAAAG	TTGAAAACGA	TAGCTCTGCT	GCCTCTTACC	CTTCTGACTT
31501	GCTTATGTTG	TACCTTGCCC	CCCATGCTCA	CCAGGAGACC	AGTCAGCAAC
31551	GAAACACAAG	TTTTTTTGCTT	AGTCAAGTGG	AATTAGCTGA	CTAAGAGATC

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31601 AGACAGACTA CAAGATATAC ATAAGAGAGA ACAATCCACC ACTTAAGTGA
 31651 AGGGGATATT TGA CT CAGTC CACCTCATGA GACATGCCTG CAAGAATCAA
 31701 GTGGATCACT CACTCAAATA GCCTCAGGAT GAACCCCTCAC AATAGTTGCA
 31751 AATTTCTTAG CATAAACATG AATACATCAA TCATAGGCCA ACATACCTTC
 R gene exon 6
 31801 TCCTGATAGC AGAATCCAAA ACCCAGGGTA TGTTTGTTC TCCTAAGACC
 31851 AATATTCTTT CATTATCAAC ACCAACCCCT ATACCAAGGA AGAAATCATT
 31901 TCACCATTTA GAAAATAAAC AGAGACTGCC TGATAATGTT TTAGAACATT
 31951 TACAAAACGC AAGGGGGTAA AGCTGCACAT CTTTTCACAT GTAAGCAATG
 32001 CATTTTATGC GTAGCTGAAC TCCTTTGATT CTGAAAAC TA TAAACTTAC
 R gene exon 5
 32051 CTTGCATCTG GACTAGAAAT TCCGTTTTAA TCCGTCTAGC AGCCTCGCTT
 32101 TCATTTTCAC TTCTTGACCC ACATAGTGAA TCTATCTCAT CAATGAAGAT
 32151 AATAGAGGGC TTGTTTTCTC TGGCAAGCTG GAATAGGTTT TTCCTAATC
 32201 TTAATAAAGG AAACAGCTGC AGTTATCTTA TTGTACACAC AAGCAAAAAC
 32251 ATGCAACTTT GGATTATGAT ACAGTGACTT TGTTAAGAAA AAGCTAAAAG
 32301 TAAAAAATAA AATGAATCCC ACATAAGATA TTAACAAAGC TACTCAAAGA
 32351 TACAACATCC CTTCAGAACT ACTAACACAG CATTAGGCTG AGATGCTGAG
 32401 TGAGATACCA CAGAATAAGG TAACTTTAGG CTTCTAGTC TTGTTAACAC
 32451 ATCTCATTTG AACATGCAGA GTGGATATAT CAAAGGCGCT CATCACTTCC
 32501 AACCCATATA TGCCCATCTT TTATGTCTTC AAGATTTTGT TTGAAAACAG
 32551 AATGTAGAAA AAAAACCTTC ACACAGAGGA AGAAACAACA TGTATTATCT
 32601 GCAGGGCTAC TGCAACAGAT GAGCCAGAAG GTGACAAGAA TCAAAGTACC
 32651 CCAACACTTC AGACCACTTT GTTGTA CAAT CACAGCTGGG TTCAGAAGGG
 32701 CATTGATCAC CATTGTGCTG CTAATACCTT TGTCCAACT AGTTTTAAAA
 32751 ACAGTCTTGA GTGCTGAAGC TGCTGTAGCA CAAAATACAG TGCATTATGG
 32801 TACTTTTACC TGACACTGCA CTGAAGCAAA GAAACATCTA AGGTTTGCTT
 32851 TAACAAGACA CATGAACCTT CCTTCCATTT AATTTCTTTA GAGTGTCTTA
 32901 TCTAGCTCTG AAAAATTAAT TTCTCTTGA TAATATTTTC CTGGAACCTC
 R gene exon 4
 32951 GGAAACTCCA ACTTACTTCT CACTCTCTCC TAACCACTTT GAGACCAGGT
 33001 CAGAGGAAGA TACTGAGAAG AATGTGGAAT TGTTGCTTC CGTTGCAACA
 33051 GCTTTTGCTA GATACGACTT TCCTGTTCTT GGAGGTCCAA ATAGAAGAAT
 33101 CCCTCTCCAA GGTGTTCTCT TCCCTGCAAG AAAGAAATCA GCTATCATCA
 33151 AAATGCTGTA TCAAGAGCAA GTCTATCTTT CTGATGAAGC CTCCCTAATG
 33201 TACTAAGTTT TCTGTATGTA CCTAAGAAAC ACCTGTCAGA TCGATCATTT
 33251 ACAGCTCAGC TGGAGCCTCT GATATAGCAG CATAATGCTC TTCTCAGACT
 33301 CCGCTTACAC TACTCACTTC AACAGCAGTA TTTAGAATGG GAAATAAATG
 R gene exon 3
 33351 CTGTAATACT GACCTGTGAA CAAGTGTGGA AATTTAATGG GCAAGATAAC
 33401 TGCTTCTTTA AGAGCTTCTT TGGCACCTTC AAGGCCAGCA ACATCACTCC
 33451 ATTTACATT TGGTCGCTCC ATAACAATGG CACCTATAAG AAAAGATTGG
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 33551 AAAAGAAATC CACGTGTATG TTTACATTAA ATAAAAACGA GCCATTTCCA
 33601 CACAGATTTT AGCATCAAAC AGTGCTACTC AAATGGATAT TATTTCTACA
 33651 GAGATTTGGC AATCTTTTTT TCTTTAACCA CAATAAACCA TCAATAAGCA
 33701 GAGAGTTGTT AGAAGTTCTG CAGTGTGCAA ACTAACTCTG CAACTGCGCA
 33751 GAAAACATAC CAATGGCAGA TACAGAAGAG TACACTTCCT AAAAAGAGAT
 33801 CAACATGACG TACACCTTGA TGAAGCAGGC CCACTACAGT AGGATGCACA
 33851 GGAAAGCATG AGCAAACACC CTGCTGTGAG CACTCAGTGT AAAAAGAAAG
 33901 CCTGGAGTAG AGACCAACAT CAATCTGTAT TGCATCCAAA CCAGAAGAGG
 33951 CAAAAAGTG TCTCACTAAG TTGCAGAAAA TGTGAACAGT TCACACAAGA
 34001 CGGATTACTG TGGAGAGAGT AAATATGTGC ACTTTTTATT TTCCCCAATA
 34051 TGTCACCATT ACAAAGGAAA ATCATGGAAT GGTGGAGGGT GATGGAGGCC

34101	CAGCCTGGGG	CCCCAATACA	TGCAGCAATG	GACAGTGAGG	TCACCGACCA
34151	AGCGGTTGTG	ATGTCAGCAA	TGGAAATGAC	TGTGTCCTCG	CTAGCCCTCA
34201	CTGTACAGAT	TTGGGATCTG	GCAGAGGCCA	GCGTGACTTT	GTACCTGGAC
34251	TTCTACTGAG	CATAGCTGCG	AGACTCGGAG	CACTGAGCGA	GTTGGTTGAG
34301	TTGTGCTGTG	GGGCTGCTGG	CAGCAGTTCT	TGGTGCCAC	CCCACAGTAC
34351	CACCAACGTT	TCCCCCAGCC	CTGCCTGTCT	CAGGCAGCTG	GGGCCACACA
34401	GGGTGCACTT	GTAGCAGCAG	AGGTGAGTGG	TGCAGGACAT	GGCCTCTGCG
34451	GCGGCTGGTG	GGGAAGTGGG	AGGGTTTGCT	GCTGAGGGAC	CAGGACATCA
34501	CAGCTGCCTG	CCCATGGGAC	GAGTGACCAT	GGCCTCTCTC	TCTCTTTGCA
34551	GTTTCGTAACA	CCTTCTGCCT	GCTGCAGTAC	CTGTGAGGGG	AGCAGCTTCC
34601	CGACCTCAGC	TCTCCCAGCC	CACCGCACAG	CCCGGGGCCA	TGGACGTGCC
34651	ATCTAACTGG	ACCTGCCCCA	TCTGCGGGCA	AATTCGGGAG	GATGTCACCT
34701	ATGTGACCCC	CTGCAAACAC	CAGCTTTGCT	ACGGCTGTGC	CATCTGGTGG
34751	GCAAACAAGA	AGCCGAGTTG	TGCCGTATGC	GGGCACCAA	TCACCACCAT
34801	CCGATACTCG	GTGAGTCCG	ACGACGACTA	CCTCGAGTGT	GCTGTCCCGC
34851	AGCCCGCAGC	ACACTCTGAT	GATAGCCTGC	AGGATGAGCA	GGGGCTTGCA
34901	GAGCCGCTGC	TCATCCCACC	TGAGCACAAC	TTCCCTGCCG	AGGTCTGGGC
34951	TGCCTTCTTC	AAAGAACATC	AGGGAGACCT	CGAGCCCCTG	CTCCACTGGC
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35051	GTGGGACAGT	GGACCACTGT	CAACTTCCTC	TGCGAGCACG	GCCTGGACGA
35101	GGAGGCCTTG	ATGCGGGAGC	TGCAGCCGAT	CACTAACGGC	GATGTGCTGC
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35201	ATCCGCCGCC	AGCTCGACCA	CCAGGAAGGC	CGTGCTGCAG	GACAGCGGGA
35251	GGACAGCCCC	GCAGCCAGCC	CCAGCACAC	CACCTCCCAT	CAGGAGCCTC
35301	CTGCCTCGGG	CCTGGGCCAC	TCCACCAGCC	CCGAGGGGCC	CAGCACCGAG
35351	GAGCTGCCCG	GCAGCTCTAC	TGGGGGACCC	GGGCACCCCA	GCACCACCAC
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35451	CGGGCCCTTC	CGCCCAGGGC	AGGGACCGCT	CGTGTGGGGG	GCCCCGCGCG
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35551	CAAAAGGCGG	CCCCGGCGGC	GGCGCTAGGC	TGGCACCGCA	CTGCCGTCAG
35601	AGCACAGCGC	CAGCGGGCTG	GGAGGCCAAC	ATCTACCTCT	CGGCCTGCTG
35651	CTTGCTGGCA	GAATAAACAT	CAGTTAAAAC	AAAGAAGAAA	ATGTCTCTGT
35701	GTTATTGACA	AGACTCTTGC	TGTTGCTGTC	CCTACCCATG	CTGCTTTCTC
35751	TCTCTTCCGG	TCCTAGAGGA	GAGAAATGCA	ACTTTATTTT	CACCATCATA
35801	ATTGAGCATT	CATGACAGTA	CTAACAAAGC	ACACATAGGC	TCCAAAAAGC
35851	CGAAGATGGA	CCCCTCATGT	TGCTCTAATC	ATAATCCAAC	CACCAGGACT
35901	TGGCTAAATT	CCTCTCCTAT	TGCCAAGCTC	TGGGCCACAG	ATTACTTCGT
35951	TTGATTTTAG	CTGCTGAGCT	GTGGTGTCCC	CCTCCCTTCA	GACTTCCCGT
36001	TAGTCAGTCT	GAAGATAAAA	ACTCTGTTAC	CAGATGACTT	TTAGATGGGA
36051	CAGCTCACAT	CTGAGCTAGT	GACCCAGCTG	CACATTTTGA	AACCCTACTC
36101	AAGACAAATC	CAAAAGGCAA	GAGAAATCTT	CCCAAATGAA	TTAATGCCAA
36151	CTACCCCAAT	GCTTATCTTT	CTGTACTCAA	GCACGGTGAA	CTGTTCACTT
36201	GCCATTTTTC	TCTACAAAGG	GCTTTCTATT	AGTTCACAAAC	CAGTTTCTGC
36251	TAGCTATTTT	CTTGTCACCT	TCCCCTTGTC	CCTTCAGAGC	TCTGTGAATT
36301	GGTTGATGGC	CATTTTCTAC	AATGGAAAGT	GTACCGCTAC	TCGTGGCTAA
36351	CAAATAAAGC	AAGTGACATT	TGTTCACTTT	TTGTCCATCT	CCTTAGAGAT
36401	TTTTACTTTT	CCTGCACGCC	TTTCTCATCA	GATAGAAAGG	AATATTTTTT
36451	GCTTGCAATC	TATATACAGG	AATCCAGCCA	CTCACTTTTA	ATGCCCTCAA
36501	TACTTTTGCT	AGGTTGATTA	CAACTCAGTT	TTTCCTGTAA	CCAGGCTCCA
36551	TCACTAAATT	AATTAGTAGG	ACAAGTAGGA	ACATGAGATT	AGTTCCAAGC
36601	TATCAGTTAT	GTGGACCTGG	CATACTGTGG	TAATTTAAAT	TAGCACACTG
36651	TAAGACATTA	CCCATACCAG	GAAACAAATG	GAACAGGACA	TCGATCATGG
36701	CTTCCTCAT	TTGTAGGTGT	AAAAGAACAG	CTGGAAGACT	AAGCCAACAG
36751	AGCGCAAAAG	GTCTTTAAAT	ATCAAGCTAA	GCCACTTCTT	TTCTATGTAA

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36801 AAAACTACTG CTAGCTGCTA TATATTGCAT CACTGGATGT GTACAGCACG
36851 TTATTTCAAA AACACAAACA ATTATGTTAC TCAACTGAGT AACACCCCTT
36901 ATCACTGCAA CACGAGGAAA TCCCGCCTGT TGCTATGAAC AAACAAGAAT
36951 CCATCTTCCC GCCTTATCAA CTTGAGTTCA AGCCTTCCTG TGAAAATGGT
37001 CCTGCTTATA CTACGTACTT GGATGACATC TGTTACTTGG ATGACATCTA
37051 TTGCCTCTAG GCAATAATAT GTCAATGCAC ATAAGAGTAA AACTAGCACA
37101 GTCTAACAAA ATAGCTATCT GGGATCTTGC AACTACTCCC TTTGGAAAAT
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37201 GGCATGCAAA CCCATACTGT CATAAAGACT GTACTTCTGG ATGTAAAGAG
37251 TATATACTAG TTGAGCCACC TAAAGACAAC AAGTTAACTG GCAAAACAAA
37301 CAAACAAACA AACCCCCCAA ACAACTAGAA ATTCAC'TTGA CCAAAGTCAC
37351 CTCTATTTAA ATAAATGGAG GCTTCAAAGT TACCTTGAAG CTGATTCTGT
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37601 CATCCTTGTA GTCTTGTTTT TCTACACTAT ATTCTAACCC CCCCCCTTCA
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37751 AGCAAAATGG CTTCACTGTA GATGCTGGCA CTTACTCCTT GTCCAGAATT
37801 GCAACTGGTC TTGGTCAATT CCATTTAGTA CTACGAACT CTCTAGTCTT
37851 GTCAGAATAA AGGAAACTGG AAGTTAAAAG TAGAAAAAAG TAGACGAGCT
37901 AGGGGACAAA TGGAATGGAG ACGTGTAGCC TCATGTTTCC TTCTACTATA
37951 AACCAGCAGA ACACAGTACA GCTCAAAAAA ATAAAACCCA TGAAATGAGC
38001 AGACAATGAA AGAAGCTGAA AATCAGGGGA GGTTTCAAGA GACAACTGAG
38051 CAGTTCTAGC TGTTCAAGAC TACCAAAAAG GGCAACCTCA CCCAGAGACA
38101 CCATTGTGAA ACCTTTCTTC TACCTAGCA AATACAAAAG AGGCTCTGCT
38151 TGTTCAGGTG GGCTGATTCA GCTCTCAGAT GTGCAAAGTG AAAACAGAT
38201 GTAATAAAAG GAGAGCGGTG CATAGGCAGG AGCAAGGCAA TAGAGCGATT
38251 CAGACCATCA GAACATCAGC CTATGACAGA ACCTTGGAAC CCTCATCAA
38301 ATGTGAGACA GATAAACTC AGACCACAGT AATCATCCAA ACCAAACCAA
38351 CCAAATCTGG ACTTATTTTC TAGTCATTAA GTATTTTCAT GCAGAAGAA
38401 TGTGTTACTA GGCTCACTGT CATCGAAACA AAAAGTATTA GTGTAAAACA
38451 GCTTTCATTC TTCAGTGAAT GTCCTACAGA AGCATTGAAA GATGTAGCAA
38501 ACAAGCACAA AAAAGCCCAT AATATTAAC CACATTATTT TTCCTTTTGA
38551 AGCCCACTGT CCTTCAGCAT TAGTAGTTAC CTGAAGCGAA GCACTTCAAA
38601 AACACTACTT AAAATGATCT CTGTTGAGAT CTAAGTTGAA TCTTAGAATA

R gene exon 2
38651 AGCGGAGTTC AGGAAGTATT TTGCTTTACC TTCTCCCAA ACATACCCTT
38701 TTCCATCGGC AGGACCAGAC TCTTTAACTG GCTTTGGTGC AGTTTTTTCT
38751 CTCTTTTTC GATATTCTTT CAGTTTCTCT GCTCTGTCCA AGTATTCCGC
38801 ACATTTCACT CTAATGCTCT GTTTTGCTTT ATCACCCCTG GTTTCATCTA
38851 AGAGTGTGAA AAGAAACAAT GCGTTGTTAA CAACAAAACA CACGTGCATC
38901 ATTCAAGAAA CATCTTTATG TGTTATCAAG ATACCTCTCT CAGGGCTCAC
38951 CACGCATCCA AATGTTTCAT TTACTTATTT TTTCCCTAT GCCATGGAAA
39001 GAAGTGACAG GAAAGAAGTT AACGCCTACA AATCAATGGT AAGTAATCAC
39051 TTTCAAATCA AATACACACC TGAACGTTGC TTTGCCTTAA AAACCTGCCT
39101 GAACACGAGT AAGGACAGTG GCACTGGAAG CTTTTTCTGT CAGTCTCTCA
39151 AACTGCTATA TAGTGTCTTA ACTACTTTTC TAAACTAAGC CATTGAGAGG
39201 CTGACTTCTT GTTTTATAGAG ACCTTTTTTTT AATCTAAGAC CACTTTATTT
39251 TTCCCCGGCC TGCTAATTTT GAAAGTTGTG CACATCAAAG GAAGAAAAAA
39301 GTCACAAAAC ATCTGAAAAA ATGAGGAGTG GTCCAACAGC CACAGTTCTG
39351 TTAGTCGCTA CTGCAGTATT CCAGATCAGC AATCAAGCTT GAAAATATTA
39401 AGTTCATGCG CTACGTTCCC AAAAGTCCAT CAGTATGGTT AAAAGCATAG

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39451 GGAAGTAAGT GGCATGAGTT AATGAGCACA AAACAACCTG TGGATACTAC
 39501 TAAGAGTTCT TACAAGAAGG GAGCAGGCAT GCAATATGCA ACTTTTGTCC
 39551 TTGCTATAAT ATAACACCTC AGCCAAACTA CAGAGAGCAA GTGTCAACTG
 39601 ACAACAACAG TCAGAAAGTT AACGTTGATG TCGACAGAGG AGACTACTCC
 39651 GGGCAATATA AAACCTGACT TCATCACCCC ATGCATTACA CTTACATTTA

R gene exon 1

39701 ACAACGTGGA TTAAATACTG CACAGCATGC TGGTACAAAC GGAAGGCTTC
 39751 TTCATAGTTT CCTGCTTTAT CTTCTTGTGC TGCCTTACTA GCGAGGTCTA
 39801 TCGCTTTCTG TAACATAGGT AAATAATTCA AATGAGTGTT GTGTGAGTGC
 39851 TTTGTGCGAT CAAAAGAGGTT TTTAAGCTGC TGCTCTGACC GCTTCTTGGT
 39901 GGCCAGCTTT TCTGCTCCTT GATGTTTACC CAAAAGAGCT GCTGTTATTG
 39951 AAGACTTGCT GTCAGTTGTC TTCATCAAAT CCCATCGGCA TCAGTGTTGA
 40001 TACTGGAAGT ACACGATTAC AAAGCAATGA AAGCAGCACC CTTTCCCCTC
 40051 TGACCCAGTG CCAGGAGTTG GTTTCAAAGA CTCATTATTT GGTAAAGCTT
 40101 TCATGAAGGC TTTAGGTACT TGACGTACAG AAGTGAGAAA TTCTAACCAT
 40151 CTCTTCAGTG TGCATATGGG GGGGAGCTCA GTGGACAGGA AACATACCTA
 40201 AATTATCACA GAAGTTCTAT CAAGGACAAT TTAGAGATGG ATTTTATTTT
 40251 GTTTGTTGAG ATAATTTCAA ATACATCTGG TCGTAATCTA AGACACTACA
 40301 TCGGCCTGTA GATATATTGA TATTACTGTT ATTCCTTTGA TCCCGAGTGC
 40351 TTTTATTAC ATTTTCAGAT ACATTACAGA TTTTATTAC ATCCTTGGAA
 40401 CATCCGTACT GCTTCAGGAC AATTAAGAAT GACAATTCCA ATGACTAAGG
 40451 CACGTATGCT TAAAAAGCC AGAGTTGACT AACGCTACCT CGAACTTCTA
 40501 CAGCCCTGTC TGCATATTTC CACCTTCTGC CAGTTTATTT CCCAAAGGCA
 40551 GGGACAGCGT GCTCGTGATG ACTGTGCTAA CATCAGGGAG CAAGGTGAAG
 40601 ATATTCAACC TCATCACAGG GTTTTCACTA CACACTGCTG TGCACATACT
 40651 CTCAACAGTA ACCAGACGCT CTGATGCATC TCAGTCAAAA CCGAGCAGAT
 40701 AAACGTCAGC CATCAGAGAA GGAGGAACAA CATTTCTCCT TCTATTGTTT
 40751 TGTCTTGCCCT TTTTGGAAGT AGAGATCACC TCATTGGATC CATCTGAAAT
 40801 CAAGAGTAAT TTATTTCAAA ACAATCACCT GACAAGTAAG ACTATGGATC
 40851 CTTTGTGACA AGTGTGAAA ACAGAGCAAC CATCTGTTTC TTTGAAACAG
 40901 AACTTGGTCT TTCTCACTG CTGACCTCGT GCTGCCCTCT ACAAAATTCAT
 40951 TGTAGAGGGC AAACCATTC AATTCAGCAC AACAAAAATA AATTCCAAGC
 41001 AATAATTTCT GTTACTTTAG TGATTTAATT ACCACAGGAA CAGTCCAATG
 41051 ATTCCTGGAT GCAGAACAA AAAAAAGGG CTATGACAAA AATGACAATA

CR1 - GG

41101 TATCCAAACA ACAAATAAGA GTTGGACTTG ATGATCCCTG TGTATCACTT
 41151 CCAACCCAGG ACATTCTATG ATGCTATGGC TCTGTGTTCT AAATGGCAAA
 41201 GACCGCCTCT GTTCAATGGT AACTCTCTTA ACAGGGCATC TTAGAGCCCT
 41251 GCTCCTCTGA AATACAAAA CAAAGGTCTA CATCCTGTGC TGACTGTTTT
 41301 TGGTATTTTT TCAAATAAAA ACCCAGAAAA CCATCACTTC GGTTTTAGAC
 41351 TCTCAGCTCT GGTACTTTAT TACATTAGGA AGGCTCTTAG CCGTCTACTG
 41401 CAATGAAAA CACCAGTAAC AAACAGGAAA TAATTTATGA AAGTTGTATG
 41451 AAATAAGGCA TAGCTGTAAC CATAAATGAG GCACAACCTG TATCTATGGG
 41501 GCTATAGTTT GAGAGCTGGA TGAACACCAC CCTCAGAACG AACATCGGCT

CR1 - GG

41551 TTGCTCTTCT GCTTACTCTG GGCCCTCTGA TTTCACAGAA GGGCGCAGGT
 41601 TGGAAGGGAC CGTAAAGCCC ATTCAGTTCC AATCCCCCTT GCATGGTCAG
 41651 GGCTACACCC CACCAGCTCA GTCCGCCAG GGCCCCATCC AACCTGCGCT

MAR (0.72)

41701 TGAGCACCTT CAAGGATGGG GCACCACAGC TTCTCTGGGC AGCTGTGCCA
 41751 GGGCCTCGCA ACCCTCTCTG AGTAAGGAGT TTCTTCCTAA CATCTAACTT
 41801 TAATCTCCCC TCTTTTGGTT TAAAACCATA CCCCTTGCC CTACCTCTAT
 41851 CAGACCATGT AAAAAGTCAG ACTCCCTCCT GTTTATAAGC TCCCATCAAG
 41901 TACTGGAAGG CTGCAGCAAG ATCTCTCCCA GCTTGGTCAC TATAAGCACT

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44451	TGAGATTAA	AAAAAAATAA	ATTAATAAAT	CAGAAAAGGC	ACGTGTATAT
44501	TTACAGATAA	CAGGCTAAAT	ATTATACTTC	TTAATTAAGC	TTTACTATAC
44551	AGTATTCCTG	TTATGTGACT	TTGCAGCTAG	TTTTCCTTAA	GGAAATACTG
44601	GCTGAATGCT	GAGTAATAAC	ATCACGACAG	ACTCCTGAGG	AGCTAATGAA
44651	GTATTACACC	AAGAGTGTAG	CTTCAGTTTG	AGAGACGTGT	ATGGTCACAT
44701	TTTGGGAATGC	TTCCCATTCG	TGAGTTGCTG	TGTTACAATA	TTCTCAAAAT
44751	CCGTGTCAGT	TATTGTGTTC	AAC TGAGTGT	AATGACAATA	AAATATATTA

CR1 - GG

44801	ATGACGTTAA	ATGAAGATAT	CATAGAATCA	TAGAACATCC	CAAGTTGGAA
44851	GAGACCCACA	GGGATCACCA	TGTCCAGCTC	CTGGCTCCAC	ACAGCACCAC
44901	CCAAAAATTC	AAGTTGATGT	CTGAGAGCGC	TGTCCAAATG	CTCCTTGAAC
44951	TCTGGCAGCT	TGGGGCTGCC	CTGGGCAGCC	TGTTCCATAC	CCACCACCCT
45001	CTTGTTCCCT	CGGGCTCTGT	CGCAGTCACA	CAGAGCAGAG	CTCAGCGCTG

CR1 - GG

45051	CCCCCTCCGT	CCCTGCGAGG	AGCTGCAGCC	GCCACCAGGC	CTCCCCCTCAG
45101	CTCCTCTGCT	CTGGGCTGAA	CAGACCAAGG	GCTCTCAGCT	GTTCCCTCATA
45151	CACGTTGCCC	TCCAGATCCT	TCCCCATCTT	TGTGGTCCTC	CCTTGGACAG
45201	TCTCTAATAG	TCTTATGTCC	TTATATTGTG	GCACCCAAAC	CTGCACCCTG
45251	TGCTGGAGGT	GCAACTGCAC	AGCACAGAGT	AGAGAGGACA	ACCCTTTTCCT
45301	GCACTCGATG	GCAGTGCTGG	GCCTGATGTA	CCCCAGGGTA	TAGTTGGCCC
45351	TTTGGGATGC	TAGGGCACAA	CGCTCAGTCA	CATTCAACTG	TCTGTCAACA
45401	AGTACCTATT	GGCCTGCATG	AGGCCTGTCT	GCTAATTGGG	ACTCTATTAA
45451	ATCACATCAC	TGTGACACTA	GGTGGCACAG	GCACACATGA	TCTCCATGTT
45501	CCTTAAGGCT	GAGTGAATCA	TGGAGAATGC	TTCTTGCTAT	CAGTTTTTGG
45551	CATGGAAAGA	GAGGAGCCAA	ACCACCGGTT	GGTTCATATG	CTTGTGCCAG
45601	GAATAGGTGA	ATGCATCAAT	ACAATAAGTC	ACGTCTACAG	CACAGCCAGG
45651	CCTCATGTCA	GCAATACTGC	TCCACTGTGA	TAGCTGAAAG	TGACTATAAA
45701	TGACTAACGT	TAGTGTGGGA	CTTTGGTGTT	AGATGACGTG	AGAGCCATGC
45751	AGTGAAAGAG	AATTAGTGTG	GCAGAGTATC	TAACAGTGCA	GGTAGATAAG
45801	GCAGGAAGGA	TAAGTGTAAG	GAAAGATAAG	GAGAAAGGCA	GGAAAGTAAA
45851	ACCTCTGTTT	TTCTCTAGTT	TTCTACCTGG	TGAAATGATG	AAGAAAGATC
45901	AGTTTGACAT	AGGTTAACAA	AAACTGTCAG	TAAGAAAGGT	AGGAGTTAAG
45951	ATGCATGTTG	TCCAAATCCC	ACTACATTAC	TTTGACCCTC	TTTCTCATAT
46001	GCACAAATGAG	ATCACTTGCC	CAAGACAGGA	CCTCCAGTGG	GCATGAAATC
46051	TGAAATCAAA	TTATTTGCTA	TTTGTGTTGC	TTATCATTTT	CAGATGAAAT
46101	TCTACACGAG	ATAATTAGAG	TGATGTCCTT	GAAGATCAAC	CTTTTTGTCT
46151	AATTAAGGTA	TTTGCTATAG	CTTCCAGATG	TATTGCTTAT	CTATGATAAA
46201	TATCCTTCCT	AACTACAAGG	CTTCTATAAT	AAGAGTAACG	TCCTCTATAG
46251	TAACCAGTAG	AAAGTAGGTG	GAAGCTGGGT	GTTCTTAGAC	AACCTGTGCC
46301	CATACATGGA	CAAAGTGAGG	AGGAGGACAC	CTCCCTAAAT	GACCACCAGA
46351	GACCACTGAA	GACCCACATG	CAAGCACAGA	AGATTCAGAT	GTGTTGGTGT
46401	AACCTTGTA	ACGCAGTAAT	CTCGTGAATA	TGTGATAGAT	AGGTGTGCCT
46451	TATGTATTAG	ATAGGCGAGT	ATTGAGAACT	TTTGGTTTAT	GGATGTGGAT
46501	AGTGCTGTTA	TCCATCTTGC	ACCCTGAGCA	TAAATAAAGC	AATATCTCTT

S gene exon 4

46551	CTATAGTGCC	TTGTCTTTTC	ATTGTATTTT	AGGAGACTTT	GAAACTGACA
46601	ACAGGCATGC	AGCTTGGGAG	TGCTCACAGT	CAGTCTGGCC	ACAGTGCCTT
46651	CAAGCCTCCC	CTGCACTGGG	ATGTGGTGTG	ACAAAAAGCA	CAAACACTGC
46701	TTTTGTAGAA	GACCCAGACC	ACAGGCTGCA	CTAGGGAACG	TGTCTGCCTG
46751	GAGCACAGTG	CCCTGGGGAG	TGCTGCTGGT	ACAGTAGTCC	TGGATGAGTG
46801	GCTTCCTTCT	GTAACCTTTT	AATTGCACTA	GAAGTACACC	AGCATGGCAG
46851	AGAAGGGCTG	GGTCCTAAGA	GCCCTTCTTT	CAAATTCACT	CAGAACTCCA
46901	GATGTTTAGG	CAGGGTGTTG	TAGCTGTAAA	GTCCAGGAAG	AAAAGGTTTA
46951	AAGCTGTACT	CGGCACCAGA	AAGACTGGAG	CCAAAATAAA	GCCACATTGC

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47001 ACCCATGGCA CTATAGGCAA AGGGTAGCCT TGGGGCAAGA CTTGATGTAC
47051 TAGAAGTTGA GGAGTCCTCA GACTCTGTGT CAAGGGGATG TGCCACAAC
47101 CTACTGTGCC CCTACCTGAA GCCTGAATCA GTACAAATGT CTCACGCATG
47151 GGTTAGGCAT CTTTCTCTCA AAGCTCTTGG TCTTTGCACA CTTTCTTCTG
47201 CAGCTGCAGC AGCAGCCAAA GGAAAATTAG GTCTTGCTTT GAAAGCCAGC
47251 CCCTTCCAGC CATGACTGGT CCCTTCTCAC TCCACATCTG TGGATGATGC
47301 TCCCACAGCA GGTGGGAGAG ACAGAGGCTT TCTTGAAGAA ACCCAGCCCC
47351 TCTAGGGGAA CACTGTAAAG TCACAGGGGA GGAGACGTGG CTTTGAGACA
47401 GTGATATACT CCATGCCCCT GGCGTTCTTC CCCTGAGTGC CACTGGTGCT
47451 GCTCAGTGGT CACATGCCAC CAAAGTCTGC ATTCATCTTT AAATGCTGCT
47501 GAGAATTCAA CCTTTGATAA ATCATCTGCT TTGACAAAAT CGACATTTAA
47551 AAATTAATAT TTCCTCTTCC ATCCCCTACT TTTACAGGCT GGCTCAAGAA
47601 AATGGGAAGC TTAATGTAGA CTTGGGTCTT ACTAAACCAT TTCCTGGGA
47651 AAGACATTCA CAGTCTGTGG CAGATGGTAG CAGTATATTT TCTCTCATAG
47701 TACAGGAATG GGTCTGGTAG TACCTCTTTG GAAAGGAAAA TGTAACCTCA
47751 TACGTTTTGA GCCAAATTCC ATCAGATTTT TTAGTTTTGT TAGTTTTTAC
47801 TCCACTCCCTG CTGGAAACTG AAAATATGGA AATGCTTGA AATTTACTGT
47851 GATTTGGGTT CAGGTGTGTG TATGCAGGAA ATGTGTTACC TTCCAGAGTA
47901 AGTCAGTTTA TTCTAGAAAT GGGATGACTC CACTTTTATA CACTTGTAAT
47951 TCACAGTGAG ATTAATCCAG CCAATTGGGA AAACAGCCTT TCTTAAATTG
48001 TGAAAAACAT GCTCCACTTC TATGTATTTT TTAATATACT TCAGCATTTG
48051 GAATTGTAAG TTTTCTTCT ACTGTTACAT GCATTCCAAC AGAATTTGTC
48101 AGGAACAAAA ATGAAATCTG AAATAATATT TTTCTTAGCT TTGCATGTGT
48151 TATCCTCAAG GGTAATCACT GTCCTAAACA ACATACTTAT GGCTGTTTCT
48201 GAGCCTTTCT TCTTCATGAA CTCATCAGAA AGGGACACTC ATATTGGCAG
48251 TCTGTATAGA GAGCCAAGGA CAAATATTTT GCCTACGTCT TCTCTGCGTA
48301 GCATTTTATA TATTAGGTCT TGCTAGTGAA TTATGACTGA ATGGAATACA
48351 GTCCCTTCAG TGATGACTTC ATTCATGATT GAATAAATGT AGCTTCAGGG
48401 CTGTATGGTT GACTTACATC ATCCAATTTT GCCATCTGCA ACAGCCACA
48451 CCTCTACCCA TATATGAATT CAGCGAGGGA TTTTGTACTA TGTGTTGCTG
48501 GGATGTAGCA GCATTTCTCT TTGAAATGTC TTTACAGATG CAATGCCCTAG
48551 CAGGCTTAAC AGCCCTACCT GCTTCAGAGA CACTGCTGTA AAAAGAAAAA
48601 GAGAAGCTTC CCAGCCAGTA TTTTCATCAAG TTAACAAAAA TCTAAAAGTT
48651 TATACTGTAC CATTTGGATT GCTGCATGTT GACATCATTT AGGATTCTGA
48701 AAACCTAAAG AAGCTTTGGA GCAACTCCTA AGTGTATGGT AGATGCTCTC
48751 ATTATGTAAG AGTGACAAAT CACTACCAGT CTTCCAAAAA TGCATGCTGA
48801 AATCAAAAAA GAAATAATGG ATCTCACAAA ACTGGATCTG CAGATCAGGT
48851 TCTACAGCCT CTGGTATGCA AGGGTTAAAG TAGAGTGATT GTTGTAGCTT
48901 GTGTCTCACA GTCAGACATA AATCTGTAAG CAGGTCCAGG TTTTGTAAAT
48951 TGTTGCTTAT CACCACATGA GCAATAAGTA ATCTGAACAC CCAATGTAAC
49001 AGATTTCTAG GAGTTAGGGC TGAAAGCATC ATGAAGTTTA TTCTTTTCTA
49051 CAGCAAAGCA GGCTCTGTGT ACCTGTCTAG CCACATTGTC TCTGACAAAA
49101 TTTATCATCA ATTCTCATCT CCATCAACTT TTAAGAATTA CAGAATTGAA
49151 GGGAGGGATT GTTGAAAGGG ATCTCTGGAG ATCATCTAGT CTTACCCCAT
49201 GATGAAGCAG GTTCCTTACA ATAGGTGGCA TAGGAAAGTG TGAGCAAACA
49251 CCCTGCTGTG AGCACTCAGT GTAAAAAGAA AGCCTGGAGT AGAGACCAAC
49301 ATCAATCTGT ATTGCATCCA AACCAGAAGA GGCAAAAAA GTGTCTCACT
49351 AAGCTTCAGA AAGTGTA AACCTCACAGA AGATGGATTA TTGTGGAGAG
49401 AGTAAATGTG TGCAATTTT ATTTTCCCCA ATATGTCACC ATTACAAAGG
49451 AAAATCATGG AATGGTGGAG GGTGATGGAG GCCTAGCCTG GGGCCCCAAT
49501 ACATGTAGCA GTGGACAGTG AGGTCACCGA CCAAGCGGTT GTGATGTCAG
49551 CAATGGAAAT GACTGTGACC TCGCTAGCCC TCACTGTACA GATTTGGGAT
49601 CTGGCAGAGG CCAGCGTGCA CTTGTGCCTG GACTCCCGTT GAGCATAGCT
49651 GCGAGACTTG GAGCAGTGAG CGAGTTGGTT GAGTTGTGCT GTGGGGCTGC

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49701	TGGCAGCAGT	TCTTGGTGCC	CACCCACAG	TACCACCAGC	GTTTCCCCCA
49751	GCCCTGCCTG	CCTCAGGCAG	CTGGGGCCAC	ACAGGGTGCA	CTTGTAGCAG
49801	CAGAGGTGAG	TGGTACAGTG	GGGAAGTGGT	GGGGAAGTGG	GAGGGTTTGC
49851	TGCTGAGGGA	CCAGGACATC	TGGACAGCTG	CCTGCCCATG	GGACAGCGAG
49901	TGACCATGGC	CTCTCTCTCT	CTTTGCAGTT	CGTAACACCT	TCTGCCTGCT
49951	GCAGCACCTG	TGAGGGGAGC	AGTTTCCTGA	CCTCAGCTCT	CCCAGCCCAC

T gene

50001	TGCACAGCCC	GGGGCCATGG	ACGTGCCGTC	CAACTGGACC	TGCCCCATCT
50051	GCGGGCAAAG	TCGGGAGGAT	GTCACCTATG	TGACCCCTTG	CCAACACCAG
50101	CTTTGCTATG	GCTGTGCCAT	CTGGTGGGCA	GAGAAGAAGC	CGAGTTGTGC
50151	CATATGTGGG	CACCAAATCA	CCACTATCCG	ATACTCGGTG	AGGTCGGATG
50201	ACGATTACCT	CGAGTGTGCT	GTCCCGCAGC	CCGCAGCACG	CTCAGATCAC
50251	GGCCTGCAGG	ACGAGCAGGG	GCCTGCAGAG	CCGGTGCTCA	TCCCACCTGA
50301	GCACAACTTC	CCCGCCGAGG	TCTGGGCTGC	ATTTTTTGAT	GGACATCCCG
50351	AAGACCTCGA	GCCCCGTGCT	CAGTGGCTGC	AGGATGAGAT	CCAGCAGTTG
50401	ACCAGAAATG	GGTGGTGGGC	AGTGTGTGTT	GGACAGTGGA	CTGTTGTAGG
50451	CCTCCTTTGT	ATTTTCGGAC	TGGACGAGGA	GGCCTTGGTG	CAGGAGCTGC
50501	AGCCATTCTC	TGATGCTGAC	TTGGTGCCCT	TTGTAAGGCG	GCTCATCAGC
50551	ACCGCTGCAG	CCCTGTACGG	CCCAGTGATC	CGCCGCCAGC	TCGACCAGCA
50601	GGAAAGGCTGT	GCTGCAGGAC	AGCGGGAGGA	CAGCCCCGCA	GCCAGCCCCA
50651	GCACCACCAC	CTCCCATCGG	GAGCCTCCTG	CCTTGCGCCC	AGGCCGCTCC
50701	ACCAGTCCCG	CAGGGCCCG	CACCGAGGAG	CTGCCCGGCA	GCTCTACTGG
50751	GGGAGCTGGG	CACCCACAGCA	CCACCACCGC	GCCCTCAGTG	GAGGAGCCGC
50801	AGGAGGAGCC	ATGGCAGGCG	GTGGCAGCGG	GCCCCCTCCAC	CCAGGGCAGG
50851	GATCGCTCGT	GTGGGGGGCC	CCGGCGCCCC	CCGAAGAGGA	AGGCCACAG
50901	CAGCCCCCAG	GCCTCACCCC	CGCCCCCAA	AAGGCGGCC	CGACGGCGGC
50951	GCTAGGCCCG	CACCGCACTG	CCGTGAGAGC	ACGGCTCCAG	TGGGCTGGGA
51001	GGCCAACATC	TACCTCTCGG	CCTGCTGCTT	GCAGATAAAA	TGTGGGGATT
51051	CAAGAAAGAA	TATTTAGAGC	ACAAGCTGCA	GAACAAGATA	AACAGCATGG
51101	GAAAGGAATG	CTGAGGACAG	AGGATGCCTC	CAAGAGAGAA	GAAAGTCAAG
51151	TGAGCTGCAT	GATCGCTGCC	TAACAATCCT	AATTGGAAGA	AGAGTATGTG
51201	GCTAGGAATG	ACTCATAACT	CTGATTGGAG	AAGCGCCTGC	ATGCGTGGTT
51251	AAGGAGTAGA	ACAAGAGCAA	GGGTGACCCT	GTGGGATGTT	TTGTTGACAT
51301	GTAAAGGGGG	TGGGAAAGAT	ACCAGAGAAA	ACTTGGCAGT	GTATTTAAGG
51351	GATATTAGAA	TATGCAATAA	ATGATTTGGA	TTGCTCATAC	ATCTGAGTCC
51401	GTGCCTTGGA	TGCTGCAAGA	AAATAAACAG	AAATTCAAAA	AAAAAAAAAA
51451	AAAAGGATAA	GAAAATGTCT	CTGTGTTATT	GACAAGGCTG	TGGGCGTTGC
51501	TGTCCTTTCC	CATGCTGCTT	TCTCCCTCTT	TTTCTCCTGG	AGGTGAGCAC
51551	AGACATGCAG	CTTTATTTCC	ATGACCATAA	ATTGGCTTTC	ATGACAGCAC
51601	TAAAAAACA	CACGAGGGCT	CCAACAAACA	GAGAAAGGAA	CTTATGTTAC
51651	TCTAATAATA	ATCCAATAAT	CAGGGCTTCA	CTAATTTCTT	CTCATACTGC
51701	CAGCTCCAGG	CCACAGATAA	TTAAGTTTTG	TTTGATTTCA	GTGACTGAGC
51751	TGTGATGTCA	CCCTCTCTGT	AGACTTCCTA	TTAGTCTGAT	GTTAAAAACA
51801	CCAAAAATAT	GTGCTGTAAT	CCAAAGAGAA	ATTATGGGTC	CCATTAAATT
51851	GGTACTTTGG	GTTCTACAGT	CTCTGTTATG	CAAGAGTTCA	AGCTAAATGA
51901	TTGCTGTAGC	TTGTGCACGA	GTTTTGAAAA	GATACCAATC	TGTGAACAGA
51951	CCCAGATTTT	CTTTCTGGAA	TTCTCCTCCC	CTGTGCAAAG	GAAAGCACAT
52001	TGTTTTTTTC	TCTCATCAGA	GAGTACTCTG	AAATGAACAT	TTTTGAGTTA
52051	GACAGTGAGG	AGCAGAAAAG	AAATTCTATT	CACATAGGTG	CTTTTAAAAG
52101	CATTACCAGA	TTCTTCTAGA	CAAATGACAG	AGGAATAACT	TTTGCCATTTC
52151	CATTACACAA	TAGAATAACT	GAAGTGCAAA	ACAAAGAGTC	ACGCTACAGG
52201	AGTAAGTTTT	GAAACTGACT	TGCTTACCTC	TGATGCTTCC	AGCTGACTTT
52251	CTCCATTCTC	ACAGTAGATT	CAAAGTTCTT	TTTTTTTTTAA	CTGTGTGACT
52301	GTAGAGAGTA	GTGTTACAAA	CTTAACTGCA	TGCTGTGCAG	TCTGAATTAG

52351	AGCTGGGGGT	AGGTGATAAC	ACACCTCCTT	CAACTGTTTT	GTTTTCTCTGA
52401	ACTGTGGTTT	GTCTCATTAT	TTTCTTCTAA	ATGCTATTTT	AAGCAGTAAG
52451	AGTTTAAACA	TGCCTTCTGC	CTGCCTTAGA	ACTGCAGAAG	ACCTTAAATG
52501	CAGAACTCTT	ACTGTTCTTG	AATTCATGGG	AAGGTCTGAG	GAAATGGGGC
52551	CATCCAAGAT	GTCCTCCAAA	CAATACGTTT	CCTCATTTCA	TTATGTGTAA
52601	GGTACAGTGG	TGTTGTACCA	GGGGGTGAGC	ACTGCAGTGG	TAAGTGCTGT
52651	TGGACCTGTC	GTGCAAGAAT	AGAAAGAAGT	CCCACAACAG	CCAAAGTCCA
52701	GTGGCTGGAC	CAGGAGTAGC	CAACTATGTG	GCTGCTGTGA	TTTGATCCAC
52751	ACCAGATTTT	CAGGTTAGCA	TTTTCTCTCT	AGACCCATCC	TTATTAATCC
52801	CTAAGCCTTT	TAATTAGTTC	TTGTATGGAA	AGTAGCAGAA	ACTGTATAGG
52851	AAGTCATTTA	TCTTTCTCTT	CATCCTAGCC	ACTCTTACCA	GAGTAATTTT
52901	CATCTTAAGC	AGGAAGCTCT	TCAAGCCAGG	CTATTATTCC	ATCATAAACT
52951	GTCTATAATT	CTTCTACACG	TATGACATTT	TGTCTACATC	TTCCAATATC
53001	TGTCTCACTA	ACAAGCCTGT	TTCTGTTTTT	TATCCACAAC	CCATCGAATT
53051	TGGTAGCCAT	CTTTGCAGTG	GGCTTTGGAT	CTTGACCCAA	GAAAGGAAAA
53101	CGGAAGGGTA	TTTGCACTGT	CACAAGTTCC	TATAGACCTA	ATTGCAGCTT
53151	TCCAAGTCAC	TTATGCCTGT	TATGTAAATG	TTAACGCTAT	TGTGGAGTTT
53201	ATTAACTCGC	TGGATTATGC	ATGAAGTATC	CTCTGGAGTT	TCCCCATCAA
53251	GCTTAATGGG	ACCATTAGAT	CTCAGAAGAA	TGACGAAAGC	TATTTCTCAG
53301	TAGCTTACAT	ATTACCTGGG	TAGATGTAAT	GGGAAAGAGA	AAAAGAAGCA
53351	TTCTGTTATC	AATTCTAGC	ACTTTCTTTT	GTTAAATATA	GGCTATTTTT
53401	TTTATCATTC	ACAATTTTTT	CTACTTTTCC	TTTTTTTATG	GCCTAGTATG
53451	TTCTGTGCTT	TGTTACACAA	ATCTAGGGAT	CCTGGGTTAG	TGGTGATATG
53501	AGCTGAATCA	GCTGCTGAAT	GTAGGAATAG	CTCACTTGCT	TTCATGGGTG
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U gene exon 2

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U gene exon 3

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U gene exon 4

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U gene exon 5

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U gene exon 6

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CR1 -GG

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CR1 -b

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MAR

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80851 AGATGGAAAA ACAATTCTCT CTAAGGAATT CTCATATGGT ATGAGTATTG
80901 GGGCCCTTT CCAGATCCTG CTGTATTCAC ATGAGTGTGA ATTAATAGAT
80951 GTGTGCAAAA TCAGCTATTT CAACTCAGA ATTCAGCACA CTTCTACTAT
81001 TTAGCAACCG ACTATGGGAT GATTTTAGGG CGGACAGATA CTTACAGTA
81051 TGATACAGAT AAGCAATCAG CTGATTCACA TTTCTCCTTT CCCTTTTTCG

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V gene exon 1

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81101 TCCCAGTAAG CTGCAGGCTT CACAATGGGC TCCATTTCTA GAATGATTAT
81151 TGAGTTTTCG CTTGATCTCT ACAATAAAT CAACAGAACA GCAAAAGGCC
81201 AAAACATTGT CTTCTCTCCA ATGAGCATCT CTACCTCCCT TGGCCTGATC
81251 CTTCTAGGGG CACGAAACAA CACTGCTGCT CAGATAGAAG AAGTAAGTAC
81301 TGCTGAAATG TTCTGAGATA CTTCCACATA GCCTGCTGTT CCCCAGTGG
81351 CAATGCTGGG CTTTGCAGCA CAACATGTGT GCTTAGGAGA CAAAGATAAA
81401 CACAAGCTCA ACTGCTGCCT TGAGAGCAGT GCTTGGTGTG CTGTGATCCC

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81451	TGCTCACTTA	TCAACTGTGA	CATTCAAACG	ATTCAACATG	TCTCACCTAC
81501	AGAGCACACG	GAGCCTGGGG	GTACAGGGTG	GGCATGCAGA	AGTCTGTTCC
81551	TCTGGTCACC	ATGCCTTTTA	CTCCCTGCAG	TGCAAGCTGT	ATGCTCTGAG
81601	ATCTTTTATT	TCTTTTCTTA	TTTGT'TTCTG	AGAGCAGTAA	GTGACCAATA
81651	CTCCTAAGGT	ATATGTGGCA	TAAGGCAGTA	GCTGGCTCTG	GCTGTGTCCT
81701	GGTGGATCTT	CATCCATTGT	ATTATAATAT	TGCCACAGGT	CAGCTGCTGC
81751	CAAGGGAAAC	TCATTCTCCT	TATGAGGTTC	TGAGTGACTC	TTGCTTAGTT

CR1 - c

81801	TAGGAAAGCA	ATGGAGATCG	AGTACTCTCA	ACAAGGGGGA	ATGGCGTCTA
81851	ACTAAAAGAG	CGGAAATTTA	GGTAAGATGT	TAGGCATATA	TTCTTTACAC
81901	AGAGGGCAAT	GAGGCACCAG	CACAGGCTTC	CCAGAGAAGC	TGTGGTGCGC
81951	CATCCCTGGA	GGCGCTCAA	GCCAGGTTGG	ATGGGGCCCT	GGGCAACCTG
82001	ACCTGGTGGT	GGCATCCCTG	CCCACAGCAT	GGGGTTGGGG	CTGAGTGGGC
82051	TTTGAGGTCC	CTTCCAACCC	AAACCTTTCT	ATGACAGTTA	ATAAATCTAC
82101	ATCACTTATC	CAGGACAGCC	CAGTAAATCT	TTCAAACAAG	GAAAATGCCT
82151	TTATCCCAGT	TAAAATTGCC	ATTAATTTGA	CCTCTTCAAC	TGCAGGT'TCT
82201	CCACGTCAGC	AATGCCGCAG	GAAC'TACAAG	CCTTGAATCT	GAGCTTGAAG
82251	GTGCAGTGCC	CGAAAACAAG	TCTGAAC'TAA	GCCAGGAAAG	AGAGTCTTCC
82301	CCCTCTCTGG	TATGTCTTTT	TTAGTACAAG	AGTCTTTCAC	TCCACAGTAG
82351	CCTATTAGTT	GTAAAGCACC	ACAGCCTGCC	ACAGGAGGGA	GTCAAGATCC
82401	CATGCACAAC	GTCTGCCTGG	TCTACTACGC	CTGATTGAAG	GTGTTCCCTT
82451	GTAATCAGCC	AAGTCCTCCA	TAAAGTCAAA	TACAAAGCCC	CCACCAGAAG
82501	GAAGATCAGG	TTACAAAAC'T	TAGATTAGCT	GAATTTAAAT	ATAATTACAG
82551	TGGGAGCTAG	CCCTACACTG	CAATC'TAATG	AGGATGCAAA	TGAACAACCA
82601	AAGCTATACT	GAGGAATACT	TGTAATTGGT	GTGTTTGAAA	TATTCCTAGT
82651	GCAACACAGA	TGGGAATCTT	AACCACGAAG	CGTTCCATGC	ACTGCTTTTA
82701	CAACTACAAA	ACCTTGGCAA	AGACTATGTT	TTAAGCCTGG	CTAACAGCCT
82751	CTTTATCCAA	CAAGGATT'TG	AACCGCATCA	GGTAAGATAA	CTGTACCTTG
82801	TAACCTCTGT	GGCGCTGACC	CCCAGCTTTC	TGGCAACCAT	ATGCTTCACT
82851	GTTGTCCCTC	CATGTGTATT	TTTGAGCATT	GGAGGTGCTT	CTTGAGCCCA
82901	TATCTCTTAG	GGTTGTTGGG	AAAGAGACAG	AAGTATCAGC	TTTCAGTGCT
82951	TCTGTTTAAA	ACAAACAAAC	AAACAAAGTC	AAGACAACAC	TCTGTAGAGC
83001	AAAAATAAAG	CAGAAGACCT	TTGACTTTTG	GCATATCTAA	CTTGAGCCAG
83051	AAGTGCGACT	ACAGCAAAAA	AATGGCCTAT	TCAAGCTGTC	TGCAAGCTGC
83101	TTCTGGGCTA	TCTTTCTATT	TGCAGCTTTG	CATTGCTGGC	TTTCCTCTTT
83151	TTCTTCTTTC	TTTCTTTTTT	TTTTTTTTTTC	CCCCTGCTGA	ATGATTTGGA
83201	TACTTGAGAA	TCACCCAACA	CATCTTGCAT	CTTCTCTAAT	TTTTTTTTTCT
83251	TTTCTATTTT	TTTAAATTTT	TATCTGGATA	CCTGCATACT	TCAGGTATGC
83301	AGTTTCTGT	GGGAAGACAT	TGTCATCTAG	AGGCAAAAAT	GTATATAAAT
83351	AATAAGAAAG	ACACAATAAT	AATCTCTTTT	TCAAAGATTA	TCTGAATCAG
83401	CTTCTGATAG	TTGATGTTTC	CAAAGCCAAA	TTTTGTCTCT	TTCAGTCAAG
83451	AAGACCCTCA	GAATTTCTAA	AACGTTTCTG	AATTGTTGAC	TTCATGTTAA
83501	AGAGAATAAG	CTCTGAACAG	GTTTGGCTAA	TTCACAATCT	TTATTCTGCT

V gene exon 2

83551	TTACAGAAAT	ATCTAATGTG	CAGTAAGGAA	CTATACAGAG	CAGCCCTTGA
83601	AACAGTGGAC	TTCCAAAGGG	CTCTTGAAGC	AAGCAGGCTA	AAAATTAATG
83651	ATTGGGTTGA	AAGCGAGACA	CAAGGTAAAA	CAGAGCAAAA	CTGTAGCTGT
83701	GCTATCTTCT	CCCTCTTCCA	GTGCTCCTTC	AAAAAGAATT	CAGCATATGA
83751	TAAGTCTTGT	TCATGTTTCT	AGGT'TTCTCA	TGCCCCGTCAA	AGATAGTTTG
83801	TTGTTCCCAA	TCATTCTTTA	GAGTCATCTA	CCAGCTAAAC	TATTTCTGAG
83851	TTAAAGATGT	GTTTGTTGTC	ACATACTGTC	ATACTCCTAC	CCACATGCCT
83901	AGCAAGATAA	CTGCAACAGT	ACCTCTAAGG	GTTAAATAGA	TTAATTGCTC
83951	CTGCAAATAG	CCAACACTGC	AGGTACAGTA	AAGCAGAGGA	CGGAAGTTAT
84001	GAGCGTCACA	GTGAGACTGG	GAACAGCATA	GCAGAGAGAG	AAGACACCTG

84051	AGGACCTGGT	GTTGACCTGC	TCTGGTCGTA	CACAGAGCAA	TGCTAACAAA
84101	GATGAGTGAT	GTGCCCACCA	GAGAGATTTT	ACTGTTACAA	GTAACAACCA
84151	ACCAGCTTTT	GCCCTTTACA	GGCACATAGA	GGTCATTGGC	TTTTTTTCTG
84201	ATTAAGCTGA	ACATGAAATA	TGCCACTTTT	ATTTTGTGAG	AGATGCAACA
84251	TCAGCAGGGT	GAAAACCTTA	TAAATCTTCC	AGCTGAACTT	AAGCCAGAAC
84301	TTACTGAGGG	AAATTACTGA	TGGATGAATA	GATTTGAAGG	CTTCTGATTT
84351	CTTAATGGTC	ATATCCTGAC	CAAACCTGTC	CTTGGGCTGA	CAGAGCAGCC
84401	TGTGACTAAT	GTGGGAAAAG	GCTGCAAACC	CCAGACCATC	ATTGCTCTGT
84451	GTGCCTGTAC	AAAGCCTGCG	CGCTTGGGAA	ATCCTACTTC	ACCTCTGTAC
84501	AGAAAAAATA	AGGGTAAAGG	GAAAGATGCC	CTCATGTAAA	CTGAAACAGA
84551	GGATTAATGG	CGCTGCGCCT	TTTACTGTGG	ACAGGTGCCA	CCTGGAACAT
84601	TCATTTTGCC	ACTGATCCCA	CAGTAGGCTA	ATTTGATGAT	CGGTGCCCTT
84651	TCCTCTCCCT	AACAGGCCAG	TACTAGGTAA	CAGTGCTGAG	AAATTTACCA
84701	TTTCTTTGCT	TGTATCGTCC	CTGTTCTGTG	AAGAAACAAA	CAGTTGGATT
84751	TCTAAGGTAC	TCTAAAGCTA	AGTTCACAGA	CAAGTAATTG	AGTCTCAATC
84801	CAGAGCCTTA	ATAACAACCTA	ATAAACACCT	GTGTTTTCCA	AAATTTCTCT

V gene exon 3

84851	CAGGTAAAAT	CAAGGAACTT	TTTGCTCCAG	GAGTGATTGA	CTCACACACC
84901	ATTCTGGTGC	TGGTGAACGT	GATCTACTTC	AAAGCATCCT	GGGAACACAA
84951	GTTTGAGGAG	AAAAATACAG	TACAGAGAGA	TTTTAACTG	AATCAGGTAG
85001	ATATGCATTG	TATAAATCTT	AGCATGATTT	ACCTGAGTTA	GCATGATTTA
85051	CATGAGTTGC	AACGACTCAG	CATTTTGTTT	CAATGGCTGA	CAAAACACAA
85101	AGCTTCAGCC	CTGATCAGCG	CTTTTGAACC	TAATAGTCAC	TATGGGCAGC
85151	TGTCATGGAT	AGAAGCCAAT	TGCAAAGATC	TCATTTTACA	CAGGCTCTGT
85201	GGGGCCATCC	TGGCTTTTAT	GCATCCCGTA	CAATTCAGCG	TGAGCCATGC
85251	AACAGATAGG	TTAAACCAAA	CCAATCAAAA	AAAGAGGCCA	GATATTAACA
85301	AGCCACATAT	ATGAAGATGG	AATTTGAAAC	AGGAAAAATC	CTCACAGAGT
85351	GTTTTGGTTT	ATTTATAGTA	TCTGCAATGT	TTAAAAAGGT	TTTTTTAAAA
85401	TATTTTTTTT	ATTTTGATTC	CTTTTTTCCA	CCGTACATAT	AAAATGGAAG

CR1 - GG

85451	TTTTCATTCG	TCAACTAAGG	TACAGAATCA	TAGAATTACT	CAGGTTGGAA
85501	AGGACCTCAA	AGATCATCAA	GTCCAACCGC	AGCCTAACCA	TAGTACCCTA
85551	ACTCTAACAA	CCATCTGTTA	AATCATATCT	CTGAGCACCA	CATCCAAACG
85601	GCTCTTAAAC	ACATCCAGGG	ATGGTAACTC	AACCACCTCC	CTGGGGAGCC
85651	TATCCCAGCG	CTTAACAACC	CTTCTGTAA	AGAAGTGTTT	CCTAACGTCC
85701	AACCTAAACT	TACCTTGGCA	CAACTTGAGG	CCATTTCCCC	TCGTCTTGTC
85751	ACCTGTTGCC	AGTGAGAAGA	GACCTACCCC	GCTCTCACTG	TAAGCACCTT
85801	TCAGGTACTG	GAAGAAAATA	ATAAGGTCTT	CTCTCAGCCT	CCTCTTCTCC
85851	AGACTAAAAA	GCCCCAGCTC	CCTCAGCTTC	TCCTCGTAGG	ACTGATTTTC
85901	CAAGCCCTTC	ACTAGCCTTG	TGAAGCTGCA	AAAAGTTCTT	TAACAACCAC
85951	ATTAATCCAA	GCTCTGTACA	GCTCAAGTCT	AACAAATGTC	TTCAAAAAAG
86001	ATGATCAAAA	CCATTTTATT	TCATTTAATT	CAGTTTTGTC	TTTATTCCAT
86051	ATGCTGTGCC	TATGTTACAC	TAAATAATGA	AGCCGCCAAA	AAAATGAACC
86101	CACAAAAAAC	ACAGATTTAG	CTCTGATCTG	AAGTTGAAGA	GCTTTGTATG
86151	GGAAAAACTG	TATTCTAAGT	GTTTCTTATC	TATACAAACA	AAAGGTCAGA
86201	AAGACATCTG	TTGCTAGCCG	TAGTGTGCA	CTGCCATTTA	TTAAGACACG
86251	TAAGAAAGTG	TAATTTTGGT	CCCTTAATTT	TTTTACTTGA	AATATGTCTT
86301	TGAATTTGAA	TACTGAAAAC	TGACCTTAGG	TAGGAACATT	TGGAACACTG
86351	CTGCAGTCAC	AGAAACTATG	AGATTGGGGG	AATCTGCATA	TACTTTTCTT
86401	CATGCACTAA	TTAATAATGT	TCTCTACTAA	AATTCTTCCG	CTGATTTAGA
86451	AGGTAAGTAA	AAACTTAGCT	AATGGTGAAA	TGAACCTTGA	GCCTTTACAC
86501	AGGATTTGAA	CAAACTCATC	ACAAAAGAAA	ATGAGGCTTA	GAAGACCTAG
86551	AAGAACATGC	CTGAGATTGC	TCTTAATCTG	TCTATTGCTT	CCTGCCTAAA
86601	ACATCTACCT	GATAAATGAC	AACCTGATTC	CTGCAGTGCT	ATTTCTTCTC

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86651	TATCCCATTC	CAAACCAGGA	CTTGCAAATC	CCATCAGCAT	CAGCTTGTTT
86701	GGCTGGAGAG	TAATGGTATT	AAGCCACTTC	ACTATCTGAT	CAGTTGCAGG
86751	GAAATTGCTT	TGTTTTATTT	TGCCCCCAG	AGAATTATCT	CCTTTATACA
86801	TGAATGGCAA	AACTGATGTT	TTACGTGTCG	TTGTATGTGC	AACAAAAATA
86851	AGAAAAAATG	TTTAGCTTTA	TAACAATTAC	TGCTGCAAAC	ACAGACTACT
86901	GATATTGCAC	CTGAAGTTTA	AACATTAAGG	TCTGTATTGC	TTGTGTGATC

V gene exon 4

86951	ATTCCAATTT	CTTTTTTAAAT	AGAATGAGAG	AAAGCCAGTA	CAGATGATGT
87001	ATCAGAAAGG	CACATTTAAA	CTAGGCTATA	TTGAAGAGCT	GGGAACCTCAG
87051	GTGCTTGAAC	TCCCTTACGC	TCAGAAGTTG	CTTAGCATGA	TCATCCTGCA
87101	CCAGGAGAGA	CAGCAGATGG	ATCTCCCACT	GGGGCTGGAA	CAGGTAAGGG
87151	TGAGGACTGC	GGCTAAGCCG	GACTGAAAGC	TGGTTGTCTG	AATTAAAGCT
87201	GGGCAAAAAT	CTAAACTTGT	TAATTTCCCC	ATCTTCTAGA	CTGAAAGCAC

V gene exon 5

87251	AATGACCTAT	GAAAATTTAA	TGCTGTGGTT	CTCTTCCGAA	CATATGTTTG
87301	AGATGGTGGT	AGAGGTGTAC	CTGCCCCGAT	TCAAGCTCGA	AGGCACCTTT
87351	GACCTCAATG	AGGTATTAAA	AGCAATGGGA	ATGACTGACA	TCTTCAGTGA
87401	ATCCAAAGCT	GATCTTTCTG	CATTGTCATC	TGAGAAATCC	CTGGTGTGTG
87451	CAAACATTGT	CCACAAGGCT	TATGTGGAAG	TCAATGAGGA	GGGTACTACA
87501	GCAGCAGCTG	CTACAGGAGC	TACCATTGTG	AGGAGGTCTC	TTCCCCTCAT
87551	AGAGGTGPTC	ATAGCTGACC	GTCCTTTCTT	ATTCTTTATT	AGGCACAATC
87601	CCACCACTAC	CATTCTTTTC	TTTGGTAAAT	TCTGCTCACC	TTAAAATCAA
87651	GGCCATCTTC	TAGCATTGTG	AGAAAAACCT	GGATGAATCA	GAAATACTAT
87701	TTTTCCCCCT	ACACCTTCTT	ATTCCTATGA	ATGATTGTAG	ATCAAAGTAA
87751	TCACTGCAGC	CAACCTAGCC	TAGAACCATC	AATTGAATGC	CCTCCTGTTA
87801	TGCTCCTTGA	ATGGCAAATA	TTGATCTGAA	TCTAAAACAG	GAGTAAGTTT
87851	TCCCTTAACC	TGACTGGAAA	TCAAGAATAT	TTTGTTCCTT	CAAGGCGTAC
87901	ATACACTCCT	GTATAGCCAA	GTATGTCCGG	CATAGCCAAG	TAATGTAGTA
87951	CACATTTTGC	CTGGCAAAGG	TAGAATTTGT	ATGCTGCTAC	CTGAGGAGAA
88001	CTGTTTGTA	CAATTTTCAG	TAACTGCCAG	TAAAAGTGGA	GTATTTTAT
88051	TTTCTCTGTA	GTTTTTGATT	TCCTGCCAGG	TGGGACTTGA	TTAACAGAGA
88101	GGGGCTTTGG	AAATGCTTTA	TACTTATACA	TAATCTGTAT	TTGTGGCAAA
88151	TCCTTCGCAC	AGTGGAGATC	TCACTTTGAT	AATTCCCTTT	CCTGTAGCAG
88201	CAGTCACAAG	CAAGCAGGAA	ATACTTATTT	ACAGCAAATT	CACGTGTTTA
88251	CTGACAACTG	TACCACCTTT	CCCCCATGA	TGTATGCTGG	ATCTATCCTT
88301	TTGCCATATA	AAACGTTTAT	GCTAGAAGCA	GCTTTGGTTT	CATTTATTTA
88351	TTTAGATATA	AGCCTGCATC	TGAAGCACCA	ACTCATCAAC	TGGAAGATAG
88401	ATGGAATATG	ACATATACCC	CTTTCACAAT	CCCTTGTTT	TTTCCACATG
88451	AGTTCTGTGA	GAAGCACTGT	ATTTTTCCTT	TTTAAAGATA	ACAACAGTAG
88501	GAACACTCAT	GGAAAGGACA	AGATTACGCC	TCATGAACAC	ATCTAGTAAG
88551	AGAGTTGATT	ATAACAGCAA	CTGAGTATGT	GGGAAGGCAA	GATTTTGACC
88601	CTCGTTTTAC	AGGATTTTTT	GGCACTCTTT	TTTGAAAATA	AATCCACCCT

CR1-GG

88651	TAAAGAATCA	CAGCATGGTT	GATGTTGCAA	GGGACCTCTG	GAGGACATTT
88701	TGTCCAACCTG	TCCTGTTTCA	GCAGGGCAAC	CATGTCCAGG	GGGCTTTTGA
88751	GAATCCCCAA	GCACAGAAAC	TTCACAACCT	CTCTGGACAA	CCTCTTCTGA
88801	GTTCCACAA	TTTTGAATGA	CACCAAAGAG	AATTTTGTAT	GCGCAGTGTC
88851	TGCAGGAATG	GGATGTGAAA	ACACACATTT	CTAAAGCTTA	ATTACTTACA
88901	TAGTGAAGTA	ATTGGTTTTT	TTCCTTGAGT	TCTGCTCTCT	GGTGAAGTTT
88951	AATGATCTGA	GATGCATGTA	TATAGATATA	CAGGTCTCTC	CAGCCCTGAG
89001	GAATGAAGAA	AAGTTTTGAA	AAGGGCAATG	TAAGCAATAG	AAATCACAGT
89051	CAAATATTAC	CTGGAAAAC	TTTTAGTCTG	AGAGATAATT	AGAAAAATAG
89101	AATTAGCAGC	TGACTGATAG	AGAGACATAA	CTGTAAAGTT	GCTGGTTTAA
89151	CACAAGTAAT	ATCTTCCTCA	CAGAGTTCTA	TGTGAGGTTT	AACTAACTAG

89201 CGTTGGCAAC TTGTGCTTTG TGACCTATAA AAAGGCAAGT ATACATTAGC
 89251 TATTAGTCAT ATAATTGAGT GTAAAGCTCC ATAAAGTAAT TCATGATTAG
 89301 CACAGTTTAT GTACCAAAAG TTACCTGCGG CTCTTTGGAT AAGAAAGTCT
 89351 AGGCATGATG TTCGAGCAAG AACAGGCAGG AGTAGGACAA TAATATTCAA
 89401 ACAACTTACC CTTACTGACT AATCTGAAAG CACAGTACAA TGTAAGCAGT
 89451 ACTTTTCCAG ATTGTGTCCA TGTTCCTATT CTGGAGGCTG ACAGCACAGA
 89501 TTGCCTACTA AGCTATGTTT TTATTACCTC CAGGTGTCAT CACTTGTTTT
 89551 TTACATACCC TGGGGAAGTT CTGAGCACCA CAACCTCAA CATCAGTCCC
 89601 ACTTCTGCAA CGACAGGAAC AGAGATTCCCT GTGATGAAGC GTCGAATAAC
 89651 ACAGTGTCTT GCTCCAGTTG TTGGAGGAGA TGGTTCATGA TAAATCTAGA
 89701 GTGAGATTAA GACACAGATG AGGTCAAATG TCATCCAGCT AGTTTATGAC
 89751 AAATTCTAAG CAGTTAAGGA ATGTGGGAAA CATGGCAAAG TTAGCAACAG
 89801 TAAAGGGAGG AATTCTAGCA AACTGGCTAT AGAGCAGGGA TACTCACCCC
 89851 CATGGATCTA GCAGTATCCC ATTGGTTTGC AGGAGGTTGC AGGTCACTCA
 89901 AAGACATATC ACTGATCTGC ACAGCTGCAG TTCAGTGGAG GATTCTCTCT
 89951 GTTCTACCAC TGAACCTCTC AGGCTTTATC CTCTTCATTC TGCTCTCATG
 90001 CACCTTCAGT TACTCAGGGC CAATGGCATG TGTGCCTCCC ATTGGGTGAT
 90051 CCGCTGTTGA TCATGCAGCA ATCACACACC TGCCACCTGG CACGCTGTTT

CR1 - GG

90101 GGCATGTGTA CTGACTTAAT GGAAGAGACC TTTTAAGCTC ATCTAGTCCA
 90151 ACTCCCCTCC ACTGAAGAGG GACACCTACA GCTAGATCAG GTTATTTCAGA
 90201 GCCCCGTCCA GCCTCCTCAA TGTCTCCAGG GAAGGGGCTT CTACCATATC
 90251 TCTAAGCAGC ACATTCCAGT GCCCCACCAT CCTCACTGTA AAAGAATTTT
 90301 TCTTTATATC CAAGCCAAAT CTCCCTTCCT TTAGTTTGAA ACTATTTCCC
 90351 CTTGTCCCAT TACAACAGAT CCTACTAAAG AATCTGTCTC CTTCTTCTTA
 90401 AGAGCTCCCT TGAGAAGGGA GCTCTTCTCA GGTACCTTG GAGCCTTCTC
 90451 ATATCCAGAC TGAGCAGTGC TAGTTCTCAG CCCGTCCTTG TAGGGGAAGC
 90501 ATTCCATCCC TTGGATTATT TTCCTCTGGA CTCACCTCAA CGTCCATGTC
 90551 TCCTCTGTAC TGAGGACTGC ACATTTGGAT GTAGTACTCT AGGAGAGGCC
 90601 TCACCAGCAT AGAGCAAGGG ACAGGATCAC CTGCCTTGCC CTGCTGGCCA
 90651 TGCTTCTTTT GCTGCAACCT AAGATACGGT TGACTTTCTA GGCTGCAAGG
 90701 GCACACTACT GACTCACGTC CAGATGCCAT CTACCACAGT ACCCCTAAAT
 90751 CCTTTTCTGG CAGGGCTATG CTCCCTCTTT TCGTATTCCA GCTTGTAAT

V gene exon 6

90801 GTAGTGGGGG TTGCCATAAC CCAGGTGCAA GACCTTACCT TTGGATTGT
 90851 TGACCTCAT GAAGTTCTCT CGGGCCCACT GCTTGAGCCT GTATGGATCC
 90901 CTCTGAATGG CATCTCATCC TTCAGGAGCA TCCACTACAC CATAACAGCTT
 90951 GGTGTCCTTT GCAAACCTTG TGAGGGTGCA TCAAAATCCT GTTGACAATG
 91001 TTA CTGATGA AGACACTAAA GAGTACTGAT CCCAGTACTG ATCCCTAAGG
 91051 AACACTACTG GTCACTGATC TCCATCCAGA CATTGAGCCA TTGACCACCA
 91101 CTCTCTGGGT TTGATCCCGC AGCCAGTTTC TAGTCCACTA GTCAGCACAC
 91151 CACTGATCAT AGCCACACTC GAAGGGGCAG TCATGCAAGC ACCACCTGG
 91201 GTATTTATTT CCCAGCACTC TAAAGCAGAG CTCTTGCTCC AGCTCATGTT
 91251 ATTTTCTGTG TGGCAAGGAG TGAGATTTCAT CGACTCTAGC AAATGGAACT
 91301 AATGGCTCCA TGTGCCCCAG GTCTCAGCTC AGCACCAGCC AGGCCAGGGC

V gene exon 7

91351 TGAGTCCCCC CACATCCAAC CCATAAGGTC CCAGAGGACT CCTACGTTTA
 91401 CCAGTGGTGC ACAGAGATGA GTTTAGCCCA AGTCCACCCC TCAGCCTCAA
 91451 CTCCCTTCAA CACCTCTTCA CCAAGAGGCC CAATCCATCA CTCCTTACCA
 91501 GCCAAAACAT ATACTTGTTT AATACCACAG CCACAAAAGC CACGTGGTAA
 91551 GGTCTGAAGA GACCAAAACT GTGGTTTGAG TAAAACAGAA GGAAAGCCTC
 91601 TACTCAGTAC CCCACTTATG ACTGAGTTAC TAGGATAGGA CCTGATTCTA
 91651 CAGCACCCCA ATACCCTGTA GATGTATTCC TTTAATTCTT CACACCAGAT
 91701 TAAGGCTGCT GCCACCACCC ACCACAAATA AATCCTTGCT TAGGCTGATT

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91751	ATAACTTACA	CCTGTGGCTT	CCACAGTCAA	ATGAGATTCC	CAGTGCCCAC
91801	CTGCGTGTTC	AACTTCCTTA	AGGCAAAGCA	TCTTGCAGTT	AGCAGAGTGT
91851	TAAGAAATCT	TCTTGTATTT	CCTTTAACAC	ACGTTTATCT	TCCCCAGTGA
91901	TGCTGAATTT	GCAAATGCTT	TAGGGAAAAA	TTGGCAGCAA	GTCTTTACAT
91951	AATTACTGTT	TAGCCTAGAA	AATAACAACC	GAGGTAGAAT	ACTTCAGAAA
92001	GTTTCTAATT	TAAGGTTTTT	TTCTTGATGA	GAGAAAAGTG	CTATCAGAGC
92051	TGTTTAGTAA	TTCCAGTCAT	GCATGGGTAA	CTCATTCCTC	TGTGTTAGGG
92101	TTTACTGAGA	GGTGAAGAAA	CAAGTAGTTT	CTTTTCCTTA	TGAAAAAAA
92151	AAAAAGTGGT	ATTAGAAGAA	CCCCATAAAA	GAATGCCAAA	CATTGCAGCT
92201	TATGATGTGC	AATGTGTCAC	TCAGTCTTAC	AGATGACACA	GCCTGGAAGT
92251	AAGCTTAAAA	AAAATGTTTA	ATTCCTAACT	TCTTTTGACA	CCATCTGTGC
92301	TGTGGTTTTAT	GACATCCATT	AATAATGTTT	ATCACTAAAC	AACAACAGAT
92351	AGAGAGACCA	GAACTAAGG	ATGCTGCTGT	CATTTCCTTC	TGATGCAAGG
92401	TAGAAACATC	AGGAAATTAA	GGCACACTGA	AATATTTTGT	AATATTTTGG
92451	ACTAGAAGCA	AAACCAGAAA	CTGAGTTGCA	TTTGTCTCCT	GGAGTACATT
92501	CTACAGGTAT	TTAAAAAGAG	ACAAAAACCA	TAAATCTACT	TGAATTTAAT
92551	TTGAAGTATC	AAATGAAAAA	GATGTACCTG	ATTTTATTAT	CCTCCACACT
92601	GGTCTTCTGA	ACTTGACCAA	TCCCCTGGT	CAGTTACTGG	TTTACGACTG
92651	CTCAAGCTGT	TTGTAGCAAC	TATGTTGTAC	CACAAAATAT	CTGAGCCATT
92701	ACAAAACAGA	AGAGTCATTA	GGCATTTTAT	CTCCAACCCA	AAGCATACAT
92751	GCATGTTTTA	AAATCTCAAA	TTCTCCTGAC	TTTAATTGTG	CATATTATGT
92801	TCACCAAACC	TTTTAGAACC	TGCCTTGTTT	TTTTTGTTC	GGTCTGTAGC
92851	TGGGAGTCAG	AGAAATTCAA	CTGTGATTGG	AAAAATGGTT	ACTGGCAAGC
92901	TATAGAGTTT	CTAAGCCAGA	AGGTGAAGAA	ATACTACTTT	TTTAACACTC
92951	TTGGCCTGGG	ACTAGACTTA	CAGACATGAT	CAATATTGAA	AGGCAATTTG
93001	GAGGTATACA	TTTTAACATG	TCCTCAGTCT	GGAGTTAGCT	GTGTGTCCAG
93051	TTTCCTCTCA	GTGTGAGTCA	AGCAATAGCA	TTAGAAAGTT	ATGCCCCAAG
93101	TCTCATCCCC	TCCTATTGAA	ACTTGGCACA	GCACATTCAG	CTGTGAAGCC
V gene exon 8					
93151	ACCAGGTCAC	AGCCCCCTTA	AAGGATTTCGG	CAACAGCTGT	GGTTGCTATC
93201	ACATGGTGTT	GATCATCGTT	GGGCCCTCA	CTGTAAGAAA	GACATTGAGA
93251	CCCTGGAGCG	TGTCCAGAGG	AGGGCAACAA	AGCTGTTGAG	GGGTCTGGAG
93301	CACAGGCCCTT	ATGAGGAACG	GCTGAAGGAA	CTGGGATTGT	TCAGTCTAAA
93351	GAAGAGGAGG	CTCAGGGGAG	ACCTTATTGC	TCTCTATAAC	TACCTGAAGG
93401	GAGGTTGTAG	TGAGCTGGGG	GTCGGCCTCT	TCTCTCGTGT	GACTAGTGAT
CR1-L					
93451	AGGACTAGAG	GGAATGGCTT	CAAGCTGCGT	CAGGGAAGGT	TCAGGCTGGA
93501	TGTTAGGAAA	TACTACTTCT	CTGAAAGGGT	GGTCAGGCAC	TGGAAAGGGC
93551	TGCCCAGAGA	GGTGGTGGAG	TCCTGACCC	TGAAGGTGTT	CAAAGAGTGT
93601	TTGGATGTTG	TGTTGAGGGA	CATGGTTTAG	TGAGAACCAT	TGGTGAAGGG
93651	CGAACGAATG	GTTGGACTGG	ATGATCTTCT	GGGTCTTTTC	CTACCTTAGT
93701	GATTCCATGA	TTCTATGATC	ATTACACTGG	ATTTGATACT	CTGTGAGCAA
93751	AGGCATTGAA	GTGGTACAAA	AAATTCAACA	TTCTGCATTA	AATTGTAGAA
93801	TCTGGCAAGT	GGAAATCGTT	TTCTATAGGC	ACAGCCACGC	ACTCAGAATG
93851	TGTTTGCAAT	TTGCTTGCAAT	TTAGTCTTCT	GCAAGTAATG	ACTGCTTTCT
93901	GTATGCAAAAT	GATTGATCCA	TGTGAAAAAA	TCTGCTTGTG	TATCTGTGAA
93951	TCAAATGCAT	TGCTTTATAA	TGTGCATTTT	GGATCATTTA	TTTGTGGAAG
94001	TAAGTGTAAT	AAACAGAGCC	TGCAATTGTG	CTTCTGCAGT	ATACAAGGCG
94051	TTACTCAACT	CCAGCTGTAC	AGTCAGTCAG	GCCCTGAGAT	AATCTAGACT
94101	TATACTTTCC	ATAGTTATTA	TAATTTTGTC	TCTTACTAAA	TCTTTGATTC
94151	TGCTTGTTTG	ATAAAGTAAC	ACTCATTTTC	TATATAGTAT	TACAATCGCT
94201	TCTAGAAGGC	ATTACATCAC	TGAATTCATA	GGCTTTCTGA	AAAACAGATT
94251	CAGAAATCAG	ATTTTCTAAC	TGTATTTTTC	CATGTATATG	TATTGGAGAA
94301	CTAGTGAAGA	ACGTGTTTAA	TATACAGAAC	TACAGATAAA	TCCAGAAAGG

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94351 AGAAGCAACA CTCAAAATAA GGATGTGGCA ATCCTAAATA GGCTGTAAGC
 94401 TGGCTTGAAG CATGTCCCTC CAAAAAAGCC ATCTGAGAGA AAATTTCTCA
 94451 TTTACCATGC ATGTGCAAGT TTCCAACTC TGCAGGTATT TTATTTTCTC
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 94801 ATTCTTGTTG CAATATGGGC CTGCATCTTC CAGCACTGTC AGACTCCAGG
 94851 TTTTAGCATA AGATCAGTGG AAAAAAATAT ACACAAATAT ACCCCTTGCT
 94901 TCTGAAGCTC TGCCCTAATT GGGATGATTG CAAATAAATG AAAAAAAAAA
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 95051 GTTTTAATGT TTAAGAGAAA ACAAGTATTC ACACATGGGT GAGTACCCTA
 95101 GCAATAATGA CAGAGAACTA TTCTGCTCTA TAGCATTCTG ATAGTATGAA
 95151 TCTCGCCTTA ATTCCATAGT CTTCTCTTAG TACCACGTCC CCCAGCTCCT
 95201 GTTGCTGAA TTAAGCAATC ACTGTGTGAC ACCTACGTCG GAGCTTAGCT
 95251 CCATTACACT CAATGAAATC AGTTGCTGGT CTTCTGTGGA AAATATACTA
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 95351 CAGCACTCAG ACCACAACCA GCCTCAAGAC ACTCAGCAGA AGGAATATTA
 95401 TGAAAACAGT AGGTGCTGCT CCTGAAGCAT AACAGCCTCC AGAGATGGAA
 95451 GACAAGAAGA TGTGCTTTGG TAGTGTGTGG TGCTCATTTC CTTGTTTCATG
 95501 AATGATGATG GGAATGACTC TGGAAGACAC ACCAGAGGCC TCTGGTGTAT
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 96251 GTGGTTTAAA GGCATAGCTA AGAGGTTGCA GAAAAGAAAG GACCACATCC
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 96351 TTTAATTAAT TTATTTATAT TAAATAAAAA AAAAAAATCC TTTGATGACT
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 96451 ACATACTACT GCAATTTTCAG AGCTGCAGAC TTGAAGAGCT TTCCCAAGTG
 96501 CTGAGATATG CAGGAAAAAA AACCCTGTAA ATTACAGTAC CAGGCATTTA
 96551 ATTTTGATTG CTAAATAAAG AAGACTCGTG ACAGTCCATG ACTACGTCTT
 96601 GGAGGGCTGC AATTACATAT GAAATATAGT CTGAATTAGG AGAGTTACTG
 96651 GCAGAGGCAA AGTTTGCATG CCAATTAATT GGTAAAAGGA GAGTACGCCA
 96701 AACACAGGCT GTGGACTGCT CTGATGAACT GAGTATGTAA AAAATAGCCA
 96751 TGTGTGTTTT TCAGTGAATA CCATGGTATA TGTCTGGTTT GAGTCAAATA
 96801 TGTATTAAAA TGA AAAAAAAA AAACAACAAG AACAGTGAAA TAAACAGTGC
 96851 TAGCATATAT TAGCTTGAT AATCAGACCT ATATAGTTTT CAAATAAATC
 96901 TTCAAGGAGA ACAAATGTA TAGTATGTAT GATAAGGATA AGTACTATAA
 96951 AACATCATCA TGAGGAGTGC CAGTCTGACA ACAGGAAAAG GAATTCAGCG

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97001 TGTGAATGAA GGGGAAAGTG TGA CTGAAAC AATTGTC ACT CAGCTTACTA
97051 CAGCAGAAGC AATCATTTAT GATCTTAGAT TTTTTTTTAT TTTTTTTTTT
97101 AACTTGCTTC AGAGATATCT AAGTAATCTC AAAAACAGGA ACAAATACC
97151 AACGCAAGGA AAAATTCTAT TTTCGCTTCA TATAATCTTT TCTTTTTTTTT
97201 TCTAGTTGCA TTCTTACCTA AAAACAACAA CAACAAAACA TTTAAACAAT
97251 GTTTAAATGT TTAGTGCTGG TTTGATTACA TCAAACCGAG TTGTTGCTGG
97301 AGATGACCAG CTATCAAGGT GCATAATGGA CTGGCAGATG TGCTTGCTCT
97351 TACCCAGGT TGCTGTGCAA ACACAATACA CATTGACATA TAAGCTACTA
97401 TGAGTTCTGA AGGGCAGTTT AGACATTAAT TCTACTCCAG GCCAGACACG
97451 CTGACTATCT GAGTGGTTTA TAGCAAGGGA CTGGTTGACT TCAAAGTGGT
97501 TCCAAGTCAA CCACTGCCAA GTGCTTAAGA CTGTGTATGC ACAACAGAGC
97551 TGATCATCTC CAGTGCAACA AATAACATGA GAGCAAAAAG CATCTGAAAT
97601 TCTGTAAATG AGGCTGTTCT GGCCACACCT TGGCTCATTA AAAGACTTTG
97651 AGAGATGCCA GAATAGCCTC TGCTAAATGT GATGCAGATG GACAAGCTAT
97701 GGAATGAATG GGTCCAGGGC ATAAGGAAAC ATTACCCTCA AGCATACAC
97751 AGGAGCTGCT GAACAACCAC AGGAAAGGAA ATGTGAAAAT GTGAACAGAT
97801 AAATGTTGGA AAGAGCCGCA TTTCTGCTGC TTAGTATGTC CTTGATTATG
97851 CCAACATTAA GGAAGAATGG CAAACCCCGT GAATTGGTTT AGGAACAGCT

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Y:OV-1 element

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97901 CTACAATGGA CTGCCTGACG GAGGAAAAGG GCAGCAGAGT CCTTGCTGAC
97951 CTCTTTCTGG TACAAACACA GATCTGGAAC AGAGTTTAAAC CAATTAGTCT
98001 TGCTTGCAAT CATGCCTCTT GAATTTCAAG AGGTGCCTTT GATTTCCCCT
98051 GGCCTAACAC CCCATCTAAA ATTACAAAAC CATATTTTGT CTGCTGAGGA
98101 CTGTGCACGG ATAGCCCGTT CTGGTCAACA TACTCAGGCT GCTTCTGCAA
98151 CAAGTTTTCG ACTGGCATTG AGTGTAGAAA AAATGCAAGA CCTGTGTAGC
98201 GGCAGACTTC TCTCTGGAGA ACATGTATTG CCTCAACTAT CTTACCTGTG
98251 CAAAACGTG GTGGTGACTG TGCTATTGCA GAGGTAGAGT GTTCAAAGAA
98301 GGCAACGTA CTGAATGAGA GAACACATCA AAAACACCTT CATGCCCTCT
98351 TCTAGGGGAG ACAGCGAAAC AAAATGTTTA TTGAGAAAAT CTTGGACATC
98401 AGTCCAAGAG ATGAAAACAC TGTCCATATG TGCAGGGCTG GTTGTGTTCT
98451 ACAGGTCCAT GCTGCATAGA TGACCACAGA GGACAAAGAC ATTGAAACCA
98501 AGCATACAAA GGGCTGTGGG TACCCAGGAA AGTTCTTCAA GGAAGCCTTG
98551 AAGGGATGTT TGAGTACCCA CCTGACCTGT AGCTGCAACC CTGATGTAAA
98601 CATGTGAAAA TGGGAGCATA AGAGAAGACA CTACACACTG CAACAAAACC
98651 TGTGCCCTTG GGGAGGAAAA GTTTGACAAG ATAAAGTAGA AGCTATTGAA
98701 AAAGGAACAT TAAACAAGAC AGGAGGAAAG CTTCTTACTA TCTGTAGATT
98751 TCCCTACTCC CGACATGACT ACTGTCATGT TGACAGATAA AAAATACTCA
98801 TTTTGAGTGT GGAAACTGAA AGCCATTCCA GTTATCATGG TCTGCACATA
98851 CACACATGAC TGAATTTTCA CAACACAAA CACAGTGCTT ATGATAAAGG
98901 AGCTCCCTTT TACCTTTACC AGTGGGTACC ACCACCACTG TGTACTGTCT
98951 GTCTTAATGT GCAAAAATTT GGGATTTCTA TTATTCATTC CCCTGGCCTT
99001 AACAGAAGCT GGATTTTTTT CTTTAGTGCT CATCAAGGC ATTATTCAAT

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SDRE fragment

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99051 AAAGAGTAAT AGCTTTTTTAC AATTGACTAA TATTTGATAT TGTGCATTAT
99101 GATTGTCTAA CAGACCATGA ATGTTCCCTC AGACAGATTT GGTAGTTTAT
99151 TTACCTGTCA TAGTAAATA GGAGGTACAG AAGATCTATG AGAATAGCCT
99201 GTGCATGTAC AATGGGCCTT GTTGCCATGA CCTATGAAGA ATGAAAATCA
99251 AAAGCTGACC ACCAATCATC CCTGAATTC CACTGGCTGT TCAGCATTCA
99301 CTTCTGAATA TCTGAATACT CTGGAGTCTG CCTTCGCAA GCAGCAAATA
99351 CTTTCAGACT GTTCCCTAAA TCTCTTCTC TTACCTATTC AACTGAGTT
99401 CTCTAATTCA TCCCAACACC TCTGCTCTGA ATTTTTTCAT AAGAAGCTTC
99451 AGCAAAATGT GCTTTCTCCT CTCAAATGTA TGCTGCAGAG CCTTTGGCTT
99501 ACAGTGGATA TAGCCCAAAT TCCAGTGAAA AACTTCAGTC TTGCCTAGGT
99551 GCAGAAATAG ATGGAGCTGT GCTTTTAAACA AGTACTAACT ATAAGCTTCT

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99601 TCAGTTCTCA AACTCTTTCA GCAGACCAA ACATTTTTC GTACAGTTT
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99701 ATCCATTACA AAATCCTCAA AATAGAATGA CCATCCTGCA GCTGACTCTG
99751 CTTGGAAGTG CATTATTTTC TCTACATCAA GTGGTTGCCA TCCATGAGAA
99801 GCATCCCTAT GTTTCTCTGC AACTGTCAGT AAGAGATCAC GTATATATCA
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99901 TTACAGTGCC CCAGAGATGA GAAGAACTG AACAGCAGGA AAGGAGACAC
99951 AGTCTTAAAA AGAAGAATGT TTTCCAGGAA TTGATGCACT TTCTTGCACT
100001 CCTTGGAAT ATGGGACTAC TCTTGCTCA CCTTTAGCAG TGGGTGCTCA
100051 TTAAATGGTG AATGGTGGTG GGTCTTCTGG TTCTCCAATC ATGTCTTATT
100101 TTCTCATAAT ATTTTGGGAT CCTTAGATT ATCTGACTGT GAGAATCACT
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100301 TAATGTTTAA ATTCTGAAGT AGAGCATGAG ACATGCTAGA CTTGAAGTTG
100351 GTACAGCTTT ATAAGATACA AGAAAAGCCT GAATAATTAC ATTCTACTAT
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100451 TCTAATGTTG GCCTACTCAG TGCTTTCAAG CACAATGAAT CAAAAGGCAA
100501 TGACAAAGGG TAGTAACTCA AAGGATGACT CTTAGAAGGC TAACAGGGGG
100551 AGTGTCCGAA AGGGTACTGT ATATATCACC AAGGACTCAG AGAATCTGTT

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X gene exon L

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100601 CAGGTTCAAC TGGCAAGCTG GATTATTACG AGCCTCTTTG ATGTTTTTCT
100651 GTAAGTACTT CTCCAAATAA AATGTAAGTT CTAAGTTGTA TTCTTGAATA
100701 TGGAAAAAAC AAAACAAAAC AGAAATATAT TATGTAAGAA CTTAGAGGAA
100751 AAAAGGGCCG CCTTCTATTT TATGATGTTG GCCCACCACA TCAGAGGCAG
100801 ATGGTGGTGG TATGGCAGTA GAGGTTGAAC CTTCCACCA ACACCCCGTT
100851 ATGTGTGTT GCTGTGTGAC AGATGGCAGC AGAGGGGCAG TCTGACAGAA
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101451 TATGTAGTAG ATCACATTTG CTACAACTA TGGATATGCT ATTATTCCAA
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101701 ACGTTTGTGT GTTTTGTGCA ACAACAAAA AAAGGAATCA GCAGAGATTA
101751 AATGTCAAAA AATGAGAATA TAGAGAAGAA GCCCACTAAA GCTATAGTTT
101801 GGCATCTAAG CAACTGGCTA GATTTACAAA GAGATTCACT CTATAAATTA
101851 CAGGACAGCA ACCTCCAATT TTATGGCCAG TTGTACAAAG AAGCAGTTTG
101901 AAACAAGCTA AGACTATTGT GGTTTGACTA CATTTGATTG AAATATCCAG
101951 AGTATGGTCC AGAGTAGACA CAGAAGAAAT GAAATGTGTT TACATTGTCT
102001 CAAAAATCAT TCAGAGTTCT CTGGATGGCT ATAGGGAAAC TCATCTAGTC
102051 CACACTGTAT TCATCATACT GAAGCACAGA TGAACTATC TATTTCTTAA
102101 AGGGCAAGTA CAAGATAGTG TTTTATAAAT GAACCAGTAC CTTTCTGAAG
102151 GAAAGTAAAC ATGCATTTGG GAAACAATGG GTCAGTCTTT ACAATATTTC
102201 TAATGATCAC AGAATTTTTA GGCTTTACAT TATTGTTTCA GCATCACAGA

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102251 AACAGCAATG AACAAAGCAGC TTCTGGGCTA CAGGAAGTAC TTTTACTAC
 102301 AAGTGCCACA CGTCAACACC ACACAGTAAT AATCCTGTTT CTTTATAGACA

X gene exon 1

102351 ACACCGATTT CAGGATGGGC TCCATCAGTG CAGCAAATGC AGAATTTTGT
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 102451 GTATTCCCCC TTGAGCATCA TTGTAGCCTT GGCCATGGTC TATATGGGAG
 102501 CAAGAGGCAA CACTGAGTAC CAGATGGAGA AGGTAAGTTA TGCAAGTAAA
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X gene exon 2

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 103401 TGCACCAGAA AAAGTGATAG GATAGTTGAA GGACATTTTG AGCACCAGGA
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X gene exon 3

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 104651 ATTTACAGCAT TTCTACTACG TAATCTTATC TGGTAAAGTA ATAAAAATCT
 104701 TAAAGATCTT AACATATCAT GCATCGAAAT AATTTTGCTG GCCCAGTTTT
 104751 AACCATTTTC TCCAGGAAAT AAGCCATGAA AACAGTCTAA TAGCATAATT

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104801	ATAAAAAATCA	TGGAACATTT	TAACATGCATT	TTATTTTCACC	TTCACAGTCT
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X gene exon 4					
104901	AAAGTGTGTG	AAGAAACTGT	ACAGAGCAGG	TCTGGAAACA	GTGAACTTCA
104951	AAACAGCATC	AGACCAAGCC	AGGCAGCTTA	TTAACTCCTG	GGTGGAAAAG
105001	CAGACAGAAG	GTAAGCTCAG	AGGAGAGTTT	ATAATATACT	TCCTTGTTAC
105051	TACTTTACCC	AAACAACATC	TGGAAAGACT	ATTCCTTCCA	TCTCCATTAA
105101	TGGATATTTT	CTGTGGAAAC	TGATGACTCT	TGCACACTTT	TTTGTGTGCG
105151	GTGACAGTGA	ATTTAAATAT	ATATGACAAA	GGCAGGGATG	CCACTGTGTG
105201	CTTTCTGTGT	AAGGAGAGCA	TAACATCATG	AAGATTGGTC	CCAGCTTCCC
105251	TACAATATTG	GCATCATTTT	ACAAGCATAT	GCTGGATGGA	TAAGAAAATGG
105301	GCTTCCGTGG	AAGAAAATAA	TGTGGCCACT	AAGTTGGTGT	AAGAAAAGGA
105351	ATGATTAAGA	GTGTATGTAC	ATTTATCAGG	AAAAAGGTGG	GAAGAAAACA
105401	AGAATCAAGT	ATTAGAAGGA	AGCAGAGTGA	GAGGCAGAAG	ATCGGTATCC
105451	CTGCTTTGCT	TTTCACTTCC	TTCTGTTCCA	TGCAAGTCTT	TTTCCAAGGA
105501	CGTTTGAGAT	ATTCTGGGG	ATGTGTGTGA	ACATTCAAGC	CTACATGCCT
105551	CCTTACAGAA	ATGCCTGGTT	AAGGGTTAGT	TGTTCTGTAT	GAAATCACTC
105601	GTGAACTTGA	ATTCCACATG	CCATCATTTA	AAGAACAGGA	AGTCAACTCA
105651	AGCTTGCTGG	TTGACATCTA	AAACAAAACA	CTCCTGCAAT	GAAAAACAAA
105701	CCCCACAAAG	CAGCACCTC	CAATCCCTTT	GCCTCATACA	TGCAAACCAG
105751	ACAGACTGTG	TCTTAGCACT	CACATGCTTT	CTTCCTTCTT	ACAGGACAGA
X gene exon 5					
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105851	CTCGTTAATG	CCATCTACTT	CAAAGGGATG	TGGAAGACAG	CATTTAATGC
105901	AGAAGACACT	CGAGAAATGC	CCTTCCATGT	AACAAAGGTA	GGGGACGTGG
105951	TCACCGCTTC	TGGGCAGGAC	AGAAAGCCAT	CAAGGGTGCG	ACATACACCA
106001	TCCTACAGTC	ATTGGTCCAT	GGTTCCTCTG	GGCCCCCTCG	TGACAGGGCA
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106101	CAAAGCACAC	CTGTAGACAA	GAGAGGAAAA	TGGAGACACA	GCTTGAGGAT
106151	CCAGCCCAGT	TCCTCTGAAG	GACTTGACAA	TCTGCCTGCT	TCAAGAGAAA
106201	CTGCCCCCTT	CTCACATTGT	CTCATGCTTC	TGTTTTGCAG	GAAGAAAGCA
X gene exon 6					
106251	AACCTGTGCA	AATGATGTGT	ATGAACAATA	GCTTTAATGT	GGCCACACTG
106301	CCTGCAGAGA	AAATGAAGAT	CCTGGAGCTC	CCATTTGCCA	GCGGAGACCT
106351	GAGCATGTTG	GTGCTGTTGC	CTGATGAGGT	TTCTGACCTG	GAGCGGGTAC
106401	GGCCCTGGCA	GGGGAAGCCA	ACTAGTTCGG	AGTTCAGTGG	GAGCTGGCTG
106451	CTGTTAGACC	TTTGGCTCTG	CTCTCGCTCC	TTGGCTGTGC	TGTGCTGGCC
106501	AGGCAGGGGA	GCACAACAGT	GGCCCAGGTG	CTTCCAGGCG	CTCAGGCAGA
106551	GGTTGGCCTC	TAAGGAGAGC	CCTAGCCTCA	ATGTTATTAA	ACAAAGAGTA
106601	CAGCAAAGAA	TACAAAGGTA	AAGGAGCGTA	GGGCTGCTGT	AATGTTATAG
106651	AAGGGCACGT	ATGGGCAATT	CTTTTCATTG	AGAGGCAGTT	TCATCTGGCC
106701	TCTTATATAA	ACTCTTCAGC	AAATGTTACT	AGAATTGATG	AGGTCAATA
106751	ATCCCTAATA	TTTTTGACAA	TATTCTCATC	AAATATTTTA	AATAAGCTGT
106801	TCTCAGAATA	CCAAAGTAGA	TGCAGAAATA	TTTGTGTTTG	TTTGGTACTA
106851	TCCACTGTAT	ATAAATTGTC	ATGGCATTTT	TTTTTTTGCA	ATCTCTTTCA
106901	CCAGCTGACC	AATCTGCTAT	GTAGTGAAAT	TGCTTTATTG	TTCTGTATGA
106951	GACACGAAAA	TATTTGTACA	GAAGGGGATG	TGTCAGGTGG	AACCAAATAA
107001	AGGAGCACTG	AAGAGGAAAT	ACTAGAGAAA	CAAATGTTAA	AATAGGAAGA
107051	TGTTGATAGG	ATGCACCTTG	GGAAACTTTC	TATTTTTTGT	TAAAAATAATA
107101	GTCTTGATTA	AAATGAACGA	TGGAAAGAAG	TTGCATTCTC	ATCACAGGCA
107151	TTTTATTCTC	TCCCTCTCTT	TTCAGATTGA	GAAGACAATT	AACTTTGAAA
X gene exon 7					
107201	AACTCACAGA	GTGGACCAAT	CCCATAACCA	TGGAGAAGAG	GAGAGTGAAA
107251	GTGTACCTGC	CCCAAATGAA	GATTGAGGAA	AAATATAACC	TCACATCTGT

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107301	CTTAATGGCA	TTGGGAATGA	CTGACCTGTT	CATCCCTTCA	GCCAATCTGA
107351	CTGGCATTTT	TTCAGCAGAG	AGCTTGAAGA	TATCCCAGGC	TGTGCACGGG
107401	GCCTTCATGG	AACTCAGTGA	AGATGGCATT	GAGATGGCAG	GCTCCACAGG
107451	GGTGATAGAA	GACATCAAGC	ATTTCCCTGA	GTTAGAACAG	TTTAGGGCTG
107501	ACCACCCATT	CCTCTTCTG	ATCAAACACA	ACCCAACCAA	CACCATTTGTC
107551	TACTTTGGCA	GATATTGGTC	CCCTTAAAGA	GAGAAAGAGC	TGGCAATAAC
107601	ACATACCTTC	CCCTCAGAAA	CAAAATCCCC	TTACCGTAGT	ATTATAGCAT
107651	AATCTTATCT	CTTTCATAGA	AAAGACATAC	CCGCAGGAGA	GGAGACAGCA
107701	CGAAGCACAC	TTACTCCTTC	CCTTCTTGTA	TTAATTTTCA	AATGGCTTGA
107751	TATGAGCAAA	GACTGAGCCA	ATGAGATGGT	GAGAATGAAG	ACACCTATCA
107801	GCCATTAAAG	TGATAAGTGA	TTTTCACCCA	AGGAATAAAT	AGTAAGAATG
107851	ACCCTAAGTC	CTTGGGAGCC	CGTTACATAG	AAAGCAATAA	GCTTTGCTCA
107901	TCCCATTCCC	TGGTAACATA	CTGCTGACAA	ACCCACGTTA	CCATTCCTGA
107951	AACATGGGCT	TTGAGATCTC	CAGTCTAGAG	GGGATGTTTG	TGGAAGAGTT
108001	TCTGGTGTGC	AGATTATTGA	TTTGTGATTA	TGTCAATTTT	ATTTTCTTTT
108051	ATTTGGTAAT	TGGGCAATGG	TATACATGTT	CACTATCAGT	GGAGTTGTCC
108101	TCTCACCATA	AGTCCTCTCA	CCTAGTTCTG	AATTTCTTGC	AGAGGTTTTT
108151	CAAAGTCCTG	AAGAGTCTCC	CTTCCATTCC	AGAGAAGGGA	AATAGATCCA
108201	GTTTTTGCATA	GGTGCAGTTA	TGCCTTTTCT	CAGAGTGCAG	ATTCAAAGCC
108251	TGAACCATAG	AGATCCAGAT	GATTCTTATG	ACCCAGAACT	CAGTGAGATC
108301	CACTGGGCGA	AAGAAGTCTC	TAAATTTTTG	TTTAAAACTT	TGGAAGACAC
108351	TTCAAATTTG	AGAACACCTT	TTTGGTGAAA	AATCCTGAAA	GTGTTGTAAA
108401	ATACTTCTTC	TAAGAAACAA	ATTAGAATCC	TATTTTTTTT	CTGCTCTTCT
108451	TTCTTACGTA	TAGATTGTCA	ACTGCAGATG	TGGATCCTCT	GGCTCAATAT
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108551	TTGATTTTGT	TTTGGTTAAC	ATAATAAAAG	AAAACCACAA	ACAGTTTTCA
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108651	ATTTTAACAA	CTGTGAGTAA	AACGTGATTT	AGCAGAAAAA	TGTATTCTTA
108701	GAATGAATAA	AGCATGCAGA	TATGAAGTTT	TTCAGGCATT	TATGACATTT
108751	TTAGGAGTAC	CTGTTTTCAA	GAAGAAGTTC	ACCAAAGACC	TACAACCAGA
108801	GTTTGATTCT	TCTCTGTATT	TCAGATGACA	AGAAGTACCG	CAATAGAATA
108851	CAAAGTTATT	CCTATCTATT	TTTCTGTGCC	ATTCCAACAG	GCATTAAAGA
108901	TGACCTGGCA	ATTTTTTCTG	GTAAATATTT	CAAGGAACAA	CTATTCTAAC
108951	AGTTTTACCC	TTTTTATACAG	AATCACAGAT	TCATAGGAGC	TGGAAGAGAC
109001	CTCACGGGAT	CATCTAGTCC	AACCCCATAT	GATTTTCATCA	TTTTATATGA
109051	TGAAATAATC	TGGAATTCAT	ATAACTTGAA	AGGCATAAGA	AAGGTTAAAT
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109201	AGTGTCAATG	ATAAAAGGTG	ATCTGTAGAG	TAAAAACAGC	TGGTGCTACA
109251	GGTATGACAC	CCACATTTT	TGTAGATTAT	CAGGATACTC	ACAATACAGA
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109351	TTTTTTGCCT	TTAGAAATGG	AAGTAGTGAG	AAGAACAGTT	CCAAGGTAAG
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CR1L					
109451	CATCTCTTAT	GTCCATAGAA	TCATAGAATC	ATAGAGGTTG	GAAAAGACCT
109501	TAAAGATCAT	CAAGTCCAAC	CATATCCTAA	CCATACTACC	CCAACTTTAA
109551	CAACCCCTCTG	CTAAATCAGA	AGCAGTTGAT	CCACTCTGCT	AAATTTAAAA
109601	GCCAGTTCAC	TTAAACAATA	AGAAAAGTAG	AGGAAGATTA	CATTTGCAAG
109651	CTACTCTTCT	ACGATTAATA	GACTGGAAAG	TGCATAAAGT	ACAAAGATAT
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109751	AAAAATTGAAG	GTTTCTTGCT	TGCAAGCAAA	TATAAAGCTT	CCCCTTTCTC
109801	AAAAAGAAAA	ACAAGAGACA	GGAAAGAGTG	GAAATTCAGC	AATACTGAAC
109851	AAAAATTGCA	ACAAAATACT	GATGGCCAAG	CCCTGGCCAC	CACTGACCAG
109901	GCAGGGGGCA	GAACATACAA	AGGGCAGGAT	AAAAGTGTTT	TCCATGAAGG

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CR1 GG

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 110751 GCTGCCACAA CGTAAGAAAG ACACAAACT ATTAGAGAGC ATCCAAAGAA
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 111301 GAATGGTCAC CGGAGTAATC CCCTCTGTCA ACACTGAGAT ACACATCTCT

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111351 GTCACCATCT GTGACAGGCT AAGGCAGCAG TGCAGGCAAC AATGTCAATC
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 111451 GCTTCTGTCT GAAAAACCTT GACCAAACAC TGGTATTCTT TGGACTAAGG
 111501 AAGCAACATA ATTCCATAGA ACAACTGAGT GGGAAATCAC CACTGATAGC
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 111751 TTTGGAAAGG ATCAGATGTC AAAGAGTCTG TTAGTTTAGG GACAGGCCCA
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 112351 GTAGTATCTT TGTAGATCCT GAGTTGTAGG CTGTCTATGA TGGCCCAAAC
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 112451 AAGCTGTAGC ATGTTGCTAG ACAGTTTGAT AGTAAAAGGA TTTAAGACAT
 112501 AATCAAAAGG TAGAGGAGAC ACAGTACAAC TTGTTGGATA ATCCTTTGAC

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112601 CCTGTTTGAA CAGAAAAACAT GCTGATTGCT AGCCTTAAGC AAGAAAGGGA
112651 GAAGGGGCAG CAGCCACAGA AACATCTTGC AGTGTGAGGA GTGCTCTAAA
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113301 CTATTGTATA TTATGACTGT CCTGCAGACC ATGAATGTTT CACCTGATGT
113351 GGCATGAAGT TACTTGTGAA CGATCTGTAA GAATGTTCTT TGAATGTGCA
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113451 ACAACTCAAA TCAACATTCA AAAC TAGCAG TGAGTTCGAA TACTTCTCTT
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113551 ACAGAAGTCT CTTCTCTGCT CAACCTCTTC TGCGACAGTA CATCTTTCTT
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113751 CCAGCAATGC TAGACTGCTC TGCAAAATGC TTTATTTTTT GCAATTCAGG
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114701 GCAAACACAG AATAGGCAGC ATGGGGTGTG TCATGACATT ATACAGGATA
Y EXON 1
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Y EXON 3

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CR1 GG

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Y EXON 5

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Y EXON 6

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 119201 GGAAAAATTC AAGATAAAGT GATCCCTACT CACATTGTCT CATGCTTCTG

Y EXON 7

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 120101 TCATCAAGAC AGATGATATG TAGGCTATAG TCAGGAAGAA GCACAAGGGA
 120151 TAAACAAATA GATTTAAGCT TAAGCGTCAC TTCTGTTTTG CACACAAATA

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120201 AATGAAATAA ATAGCAACAA GTGGTATTAA TACAGTTGGT ATGGCCACCA
 120251 TACTCCTGCT TTATGCATTT CATTGTCTCT TCTCTTTGCA GATTGAGAAG
 Y EXON 8
 120301 ACAATTAAC TTTGACAAACT CAGAGAGTGG ACTAGTACCA ATGCAATGGC
 120351 AAAGAAGAGC ATGAAAGTGT ACCTGCCCCG CATGAAGATC GAGGAAAAAT
 120401 ATAACCTCAC ATCTATATTA ATGGCCTTGG GAATGACTGA CCTGTTTCAGC
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 120601 GAAGAGTTTA GGGCTGACCA TCCATTCTCT TCTTTCATCA GATACAACCC
 120651 AACCAATGCT ATTCTATTCT TTGGTAGATA TTGGTCGCCC TAAAGAGAGA
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 120751 TGTAAGTATT TAGCATAATC TCAATGCAAT ATTTTATCCA AGTGGAAGC
 120801 CTTCAATATC TAGGGAGACA TTCTTGAAGA AGCATGTGAA ATTTTCAGATC
 120851 TTTATATGCA GGAATTTATT CTCAGCTTAG ATTCAGGATT CATATCCAAG
 120901 GTGTACATAT TCCCAATGTG CTTGAATAAC TTGGGAAACA GGGCCAGTGC
 120951 TTTGGGGTTT TTTTGTGTTT TTTGTTTTTT GTTTTTTTGG TTTGGTTTGT
 121001 TTTTTTCTGG TTGGTTGTTT TTTTTTTTTT TGTGTGTGTG TGAGATTCTG
 121051 CCATTGTTAT TGAGAATCTG GTTCTCTCTAT AGGAGTTCTC TGAAATAAAC
 121101 ACAGCTTTCA GGAAATCCTT GGTCTTTTCC ATTGAATTAG CTGGGCAGTC
 121151 ATCCTAGAAC TGATGCCTGG ACAACTTGCA GATGAAATTT TTAACCTCAG
 121201 CAGACCATTT GTCTTCCAGT AATCCATTTG GACTTATTCG TGCTGCGTAA
 121251 CATTTTTTCT GAGGGAGCAT ACAGAAAGTC TACCATTTCT TCTTAAATCA
 121301 TCTCCAAACA AAACATCTTC CTGATTGATA TTATTTCCCA TTTTCATCCC
 121351 AGTGACATGT CACTGATTTT GTGAATGTTA ATTAATGGTC TTTCTATTTA
 121401 TTCTAATAAA AGCTTCGCAA ACAAACATG TCATTACCTA TTCTGGGTTA
 121451 CTGTACTACA CAACCTGAAA AATACGATAT AGCGGGTAAT AATTATTGAC
 121501 AGAGGTGACT AAGCTGGTAT GTGGATCCTA TTTTCAAAAT CAGAATGTAC
 121551 CATATATATG GGTCACTAAA TATTTTAAGA TTAATAAAAA AAAAAACAAC
 121601 TGGGTTTAAT CAAGGTAAAC CCTATAGCTC CTACTCTTCA ATTGAGCTTC
 121651 TCCCAATACA GCATACCAA TAACAAAATT TTTTGAATTT ACTGAATTTT
 121701 CAGAGAACTT TTACAGAAAT CCTCTAAGGG TCCTCAGTAA ATACATGAAG
 121751 GTGATGTGTA CAAGATAGAA TTTTAAATA TGAGAAAGGT ATTAAGAGGT
 121801 AGACTGCTTC AGCTTTCTCA TGCTGACAAG AATCACATGA AGAAATCTTT
 121851 CTATTGCCCT ATGTGATATT CCTCTCGAGA TGTTGTATGC TATTTACAGG
 121901 TCTTTAGAGG AAAGGGTCTT TAGGTTATAT ATTATCCAAT TATAATGGTT
 121951 ACTAGTGTTA ATGACAGTTT TCTGCTAGGA TACACATGCA GAATTGCAAA
 122001 TTACAGTATT GGTACTGAAA ATGTAGCGAT ACTTCAGTAA TTCAGAGCTG
 122051 CCTCAAACAC ATGCCATGTC AGCATTAAC ATAACTTGAA ATGATGACAT
 122101 TAGCAGCAGT GAAACACGTT TCATACCCAC TAAAAATGGG AGAAATGCGA
 122151 TTAAGGTTCT TCCCAAGAGG GTCAGAAGGA TTAGGTACAG TTTGCACAAG
 122201 GATTCAAGTA AAAAAAGTA TTTCAAGAGC TATGAAATTT CAAGTTTAC
 122251 TGTGTACATC ATGTTATTTT CCTCTTACAG CTGAAATCAG TCAATACAGT
 122301 TTTGCTACAA CTAAACCAA CCAACCAAAC AAACGGCAAA GAAAAAAGG
 122351 CAGGACTGGT AAAATATTGT CCTGAGCAGC AGAGTGTGTA AGGTTACTAA
 122401 GCAGTTATAA TACTGTGTTG GAACTGAAAT ATGCAGCTAT GTCACCTGTC
 122451 ACTTTCTAGG TACAATAACA GTAAAAGTAC CCACATTTAC TATGGAGGTA
 122501 TTTAATATAT AGCGTAAACT AAAAAACAG CTATTCAATT GTTTGATCTT
 122551 TTTAAAGCAA AAGATGAAGA AAATCAAGGC AGAAATGATA AATGAATTTT
 122601 AAAAATATA CAAAAGAGGG TATTCAGGC ACAGAGTCCA CCTAATGTCT
 122651 TAACTGTGAA ATGGAAGCAT TTGACTTGTT TTAATAAGGC CATTAGGTGT
 122701 CACTAAGGGT AAAAAGTTAC GTTTATCAGC TTTTCAGAAAG AGGATGGCAT
 122751 TCCAAAGGTG CCTCTGAGCT CTGAAGCCCA GCAAGGGATA AGAGAAATGA
 122801 ATCCAAGTC CAGCTATTGT CAAAAGTCC TTTTGTGTTT CTGATACCAT

122851	GACTGAAGTT	GTCATGTCAA	GACATTGCCT	TCTGTCTGTT	CACTACACCT
122901	CATGTTCTCT	CAGTGCTGTG	TTCTTAGAGA	GGCAGTACTG	CTAGTGGTCC
122951	GCGGAATGAA	AACAGCCAGG	TGTAATCACA	CTCTTTTGAA	TGCTTCATGA
123001	GAAGTGCTCT	CTGGACTAAG	TGTAAC TTTC	CTTCTCACAT	CATT TGAGAG
123051	AGGGACCATC	ACAGAATCAT	TTGGAGACCA	CCTGCATCTA	TTCTGCACTT
123101	CTCTCCACAT	TTGCCTATCG	TCTTCTAAGC	AAACCGAATC	TATGGCTGAA
123151	GTTACAAGAC	TCTGCATGTG	GTGTCACAGT	CACCAGAGGC	AGAGGACTCA
123201	AGAGAATATC	CTGGTCCAGA	GCTACTCTGG	GATCTCAAAA	GTCAC TTGGG
123251	AAAGCACAGC	ATGTTGAACT	AGACTTTGGT	GTATTTTTTCC	AATCTTTATC
123301	AGTCTACAAA	ATATCAACTG	GACATGGAGC	AGTGGTTCAC	TTTGGTGTTT
123351	CCTGTGGCTC	ATGATCTAAG	ATTCTTCAGT	CTGGAAAATA	AACTGCAGAG
123401	ATTACTGTTG	AGGAGCAGCA	AGTGT CAGTC	TGCTCAGCAA	GGGAAGGAGA
123451	CTGAGGGCAA	GGGAAGGAGA	CCGTGCCAGT	AAGGCTAGAA	GGGCCCGATA
123501	AGGGATCAAG	TGCTAAATTT	TCCAATATTA	TAGCCATAGT	TTAGTGATTT
123551	CCAGAGAAAT	ATGTAGTGAT	GTGGTAGGCC	AAAGATCAAA	CCAGAAGGCC
123601	CCAGAATGGC	AACAGGTGAT	GATCCCTGTG	GCACATTCTC	TATCTTGAAG
123651	TAAAACAGCA	TGGATCCATA	TAAATACATT	CTTGCTCAAC	AGCAGAAATA
123701	ACAAACAGTA	TTGCTTACTT	CTACGAATAT	CCTAACAAAA	CATGTAGATC
123751	ACAATGCCAC	TGAACCTTTG	TATGGATGGA	ATCTGTGCAA	TCTGCCATGA
123801	CTAAAGCTCT	GTCCAAA ACT	GCACAAC TTA	GGGTGCCCAG	CTTCTGAAGG
123851	GATGTGAAAT	TATCTGTGCT	ATCTCCTTTT	CCCTTCTTGT	GTTAGCTCCA
123901	GTAAACTCTA	TTTTTAAGAAA	TACCTTACAG	TTTCTGATTG	TCTTCTTTAC
123951	TGGTATCCAA	AGGGACTCCT	ATGCATTACA	GGGT CCTCCA	GCACAGTGAG
124001	GTTCTTG GCC	TGGTGCAGGC	ATGCAAAGTA	GCTTAGGCAC	GGGTCACAA T
124051	CAAGATACTC	AGTTTAATGC	TTCTCCCAAG	TGATGGGATG	CTAAAATCTT
124101	ACATGATTTT	AAAAGGAAA G	TGTTCAA ACT	GTGGAAGAGA	AATCCACTGA
124151	CAAATAAGAA	AGATACAGAA	AATAAAGTTA	GCTATAGAAG	ACATGGAACA
124201	GGAAATAATG	TTAGA ACTCT	GAGGGCAAGA	GTAAGCCTTA	ACAGTAATGA
124251	CAAGCCTCAC	TGGAGGAGCT	CTTCCACATA	CGTTGTTCTC	ATGGGCCCAG
124301	GAGTCTGTAC	TGGAAATTGG	CACACAGTTT	GGGTACCGGG	GGCGATCTTT
124351	GTGAGATGAA	GCCCTGAACT	GCCCTGGGTC	AGCTGCAGGT	GTCTCTGTAA
124401	TGGATGAAAA	CAACTCACTG	TGCACCAGAT	TTTCAGCTAA	TAAGAAAAGC
124451	ACATGGCATC	TCTGCTCAAA	CAGAATCATA	GAATTGCTCA	GGTTGGAAAA
124501	GACCTTAAAG	GTCATCGAGT	CCA ACTGCAA	CCTAACCAAC	TACCCTAACT
124551	CTAACAACCC	TCCTCTAAAT	CATGTCCCTG	AGCACCACAT	CCAAACAGTT
124601	TTTAAACACA	TCCAGGGATG	GTGAATCAAT	CACATCCCTG	GGGAGCCTAT
124651	TCCAGTGCTT	AACAACACTT	TCTGTAAAGA	AGTTTTT CCT	GATATCCAAC
124701	ATAAACTTAC	CCTGGCACAA	CTTAAGGCCA	AATTTAATTA	GAAAATGTAG
124751	CAGCACTGCA	ATGTAGCAAA	TGTAATTACG	AAAAGGTGGT	AGCTGCTAGG
124801	GACAGAGGAC	ATGCAAATAG	ACCCAAAAGA	TAAAGACTAG	AAACAGAAAA
124851	AGGGGACATG	TGAGAGGTAT	GTTTGAGAGAA	ACATAACAGA	GGAGATATTT
124901	GAAAGGAGAT	CTTGGGAGCA	CAGGCAAAGA	CACAATCCTG	GGAGGAGGTG
124951	CTCCATGCTA	GAGGATGTAC	CTCTAAGGCA	CCGCAGCCAT	GGGCAACCAA
125001	CACAGGTCAG	CGTCATCCTG	GTGAGACTGT	ATCCCACAAG	CAGCTAACAC
125051	TGGAGTAGGG	ACAGCCCCGA	AGAACTGCAG	CCCAGGCAGC	ACACTAGAGC
125101	AGAGAAATCT	AGTTAGCAGC	AACCACTGGC	AGACAGAAAT	GATTATATAG
125151	ATTACATACT	GACCCTAGCC	TCTTACACTG	CCTACTGCAT	CACTGAAAGG
125201	ACTGGGAAGA	AGAGAGTGCA	ATAACGTAGC	TGAAACTAGG	AGGAAGGCAA
125251	GGAGAACTGA	AGCTGACTAG	GGAAAAGGGG	GATTAAAGGT	TTAAGTGTCT
125301	ATTCCATAGT	TTGCTGGTTT	GTTTTTTGTC	AATTCCTGAA	TCAGTAATTT
125351	TTATGTTAAT	TAGCAAAAAA	TTACAAACAC	TCCCCAAGTC	AGGACTGTTA
125401	CCTACAACAG	AAGCTCAGAT	CAGCTGAGCC	TTAGTCTTTT	GGTCCCTCCC
125451	TAGGGAATGC	TGTATGTGTC	TCTCTCTCCA	GGCCTGCTCA	AAATTGACCT
125501	CAGACCCAAA	CTTTTGCTGA	ATCTCCAGTA	CCACCTCTTT	TGCTCCTAAC

125551	TAGATAACAA	AGCCCTGAGC	GCTTTGCTTT	TAGCAAAGCC	TTTAAGTGCC
125601	ATTACCAACT	GCACCTGGAG	CCTTTACCTA	CCCCTATGGA	CCCAGGCTCT
125651	ATATTTAAGC	TCTGCCCTGA	ACCTTCACTT	CTTTCCTGTC	CTAAGTTAGA
125701	TGTACTAGTA	TGGTGTGTAC	TATGTCTCCA	GTTCAAACAC	AGCTGTGCCC
125751	ATACCTGGCC	AAGGACTCCT	AGTATGACCT	GGGCTGTGCC	TTGCTGCTAA
125801	GGACCTGCTG	GGTGATTGCT	GGACCTGATC	CTAATCCTGA	ATTAAGAAAT
125851	GATTTCTTGG	CTTGACTGGA	TGTGCCCTGT	GGTATGATAC	TGCCTTATGA
125901	TTTGGACTCT	TGTTTGCAGC	TGTGCAAATC	CCTAAGGAGC	CCAGTCTCTG
125951	GCCACCTGGA	ATCTTGTCAC	TACCAAACCT	CCTGAGGGAC	TGGTCTTGCT
126001	CTGGGTTCCTG	ATCTCTGGAC	AGTACTCACC	CTTTACTCAG	CCCAGGCTCC
126051	CAGTTAAGCC	CCTTTCCACC	CTGCCAGGCT	CTCCGCTCCA	TCCCTAGCAG
126101	GGGCTCTCAT	GACAGTGTGA	CCCCCCTTA	CTCAGGTCAG	GGCCACTTGT
126151	GCCACGTTCC	TTTCCTGTCT	TCTGTCCCTG	CCTTGGCTCT	AAAGCAGTGT
126201	GCTACCATCC	ACAACCACTG	CATCTCTCTA	AAGTAAGCCT	CTCCTGAGCC
126251	CAAGTCTCTG	TAACGAGGAA	GGATGCACTT	TGCTCAGAAG	GATGCCGAGGC
126301	TGCTTCTGAG	CTCTGAGGGC	ACTGACCTCC	CATGAGGTAC	ACCCCATACC
126351	CAGGACCACA	ATTCAGCCTG	CTGGAACCAT	CAACTCCTGC	TGGAGTAAGG
126401	CCATAGCAAG	ACCAGCATCC	ACCTCCCTGC	AGCCCTGCCC	TGCCCAGATA
126451	TTGGGCCTGC	TGATCTCAGG	ATGCAGACTT	GCTTCTCAGC	TTGACCTAAG
126501	CATTGCCCTG	TCTTTATGGA	CCCACCTGGT	TAGCAAGTTC	AGTGCAGAAG
126551	GAGGCTGTTG	GCATCTAGCT	AATTTTCCAC	CCACATTACT	GTCTGCTGAC
126601	TCATTCTACG	TCTCTCCCAT	CTTGTTACAA	TAATAATTTG	GGAGATCATA
126651	TTGAAGGTCT	TAATAAAGTC	AAGGCATGTG	ATATTCTCTG	CTTTGCCTTT
126701	GTTTCTAGAA	TAAGCCACTT	CATCATAGAA	GATGAAAATG	CTGATCAGCA
126751	GAGATCTGTG	CTTGATAAAAT	CCATGCTGGC	TTTTCCCTATC	ACCTTATATT
126801	CCTTCATATG	CCTTGAGACA	CCCAAGGAGG	CCTTGGATCA	GAGCTGTCTG
126851	TAGCAGTCCT	AACCTGGTATA	CAATTAGTTG	TACAACAGGT	AGTGATCCGC
126901	ATAATAGTTG	GCGTGAGAAA	GTGGGCCTGT	GCTGTGTCAA	GCATAGAGTT
126951	TGGGTTCCAG	TCCTGTTCTG	CATGGCACAT	ATGCCTGAGC	AGCTGGGTAA
127001	TCTCTGCATT	CCAATTGGAA	GGCAGGGGCC	TGTAGGCAGT	TCCCACCTTG
127051	CATGGGTGAT	TGTACCACCT	GTGTCTCAT	CTGTGAAGCA	TCATGTTTTTC
127101	ATTCAAATAT	CCTTTTGT	GACAGTAGAA	ATGAACAGAA	TTGTTTTTTTT
127151	TTCCTAAGCA	AATTCTGCAA	GAGCTCTGAA	GAACAAGGTG	TCAGTGAACCT
127201	TCTAGCTCCA	TAGATAGGAC	TTGCATCACA	TGTCATGCCT	TGATTGGAGG
127251	TCTATCCGAT	ACTGAACAAC	TTGTGGTTCC	CTGAGGGAAT	GTAAGATTAC
127301	TGATACTACT	CTCTCTTTAT	GTTAGCTACA	ATAAATGGTA	GGTTAAGCAA
127351	TAGATACAGA	GTTTGAGTGC	CTTTCTTACA	AGCATCATAG	TGAACAAATC
127401	CACTGGTGAT	CTACCTTTTC	AATAACTACA	GAGAATTGTA	ATCTCTTGGA
127451	TTCTCCTCCT	TCCCCGTTCT	GAAAATGTGT	TCTTTTTC	CAAATCAGAA
127501	ACCTTCCTCA	ACCACCCTGA	CTATTCTTTG	GACATTGTTT	TGTTCTTGCT
127551	CCTAAATAGG	CTTTATAATT	TTTGTAAGTG	AAAGGCTTTG	CATGCAGGTG
127601	AGGCTACAAC	TCATTACAGTA	ACAATGAGGA	AGACTGTCAG	ATTTTGGGGA
127651	AAATTCTCCC	ACCCAACCTT	TTGCTAGCCA	GTAAGATGTA	ATCACTGAAT
127701	GTCATGCCAC	AAAGACCATA	CCAACATCAG	ACCACATATC	TACAGGAAGC
127751	TTTAAGGAAT	CATTGACTGT	ACAGTGAAGG	GTAAATCAAA	TTAAATGAA
127801	TGTGAGGTCT	GATACGAGAT	ATCCTCATGG	GAATCAAGAG	CAAAGACAAA
Y:OV-1 HOMOLOG Y HS-III SITE					
127851	TAGTTTTTCA	CAGTCTTGTC	ATGATCTGTC	ACAGACCAAG	GCAGCACAGC
127901	AGGCAACAAT	GTTGGTCTCT	TCAGAATGGC	ACAGACCCGC	TGCAGAAAAA
127951	TGCCAGGTGG	ACTATGAACT	CACATCCAAA	GGAGCTTGAC	CTGATACCTG
128001	ATTTTCTTCA	AACAGGGGAA	ACAACACAAT	CCCACAAAAC	AGCTCAGAGA
128051	GAAACCATCA	CTGATGGCTA	CAGCACCAAG	GTATGCAATG	GCAATCCATT
128101	CGACATT CAT	CTGTGACCTG	AGCAAAATGA	TTTATCTCTC	CATGAATGGT
128151	TGCTTCTTTC	CCTCATGAAA	AGGCAATTTT	CACACTCACA	ATATGCAACA

128201	AAGACAAACA	GAGAACAATT	AATGTGCTCC	TTCCTAATGT	TAAAATTGTA
128251	GTGGCAAAGA	GGAGAACAAA	ATCTCAAGTT	CTGAGTAGGT	TTTAGTGATT
128301	GGATAAGAGG	CTTTGACCTG	TGAGCTCACC	TGGACTTCAT	ATCCTTTTGG
128351	ATAAAAAGTG	CTTTTATAAC	TTTCAGGTCT	CCGAGTCTTT	ATTCATGAGA
128401	CTGTTGGTTT	AGGGACAGAC	CCACAATGAA	ATGCCTGGCA	TAGGAAAGGG
128451	CAGCAGAGCC	TTAGCTGACC	TTTTCTTGGG	ACAAGCATTG	TCAAACAATG
128501	TGTGACAAAA	CTATTTGTAC	TGCTTTGCAC	AGCTGTGCTG	GGCAGGGCAA
128551	TCCATTGCCA	CCTATCCCAG	GTAACCTTCC	AACTGCAAGA	AGATTGTTGC
128601	TTACTCTCTC	TAGACCCCCA	AGTCAAACCA	ACTATGCAGG	TATGCTGACA
128651	ACACTATGAT	GACAGCCTGT	TCTGATCAAG	ATCTCATTTG	TTCATGGACA
128701	ATTTTGTGTT	CTTGACAGCT	GTCTTCCATT	GGGAAAGAGT	GTAGTATATC
128751	CTTCTCATCT	GACAGAAAAG	CAGAAATTCT	CATGCTCCAC	ACTTAATCTA
128801	CATTGTTTTA	AACCACCGGC	TACTTCTTGG	AGAGGAAAAA	TGGCTTTTAT
128851	AAGTGCACA	AAACAAAGCT	CTGCAAGTCA	AATGCATACA	AAACTGTTCT
128901	GTAGTCTCGG	AATCAGGACA	CTATGTGGAA	GTCAAATAGA	GCAGCTTTAA
128951	AAAGCCTTTG	GGATCATTTCT	CATCTTATAT	TTGCAGCACG	ATACTATGAC
129001	AGTGATAACT	GACATAACTG	CATCAATTTT	CTTGATATTT	TATTTGTCTT
129051	AAAGTACAAG	ACATAGAGAT	GGACGTAAAG	ATGGACATAT	GACTCAGGTC
129101	TGGACAGGTC	CGTGGTCCAT	GTATGATAAA	AGAGATGAAG	GGAAGGAGAA
129151	TTGAGACTGT	CTAAGAAGGG	CTTCAGGGAC	GTTCTGAAGG	CAGATTTGAC
129201	TGAATCAGAT	GTACTGTCCA	AGTCTCATAT	GTAGCAATGG	AAGGCTGATA
129251	TTGGAGAAAT	ATAAAGAAAT	GGCTGTGAAC	TCAAAGTGAC	CCTGAACAGA
129301	AAAGGGATAT	GGAGTTAAAA	TAATGTCACA	GAAGTGAAGT	TTATATGATA
129351	TACCATGGGC	TGCAGAGGGT	CAGAGTGCTC	CACCATGGGC	CTCTCTTGGG
129401	CTGCAGGGAA	CTTCTGTTCT	ACACCTGGAA	CACCTCCTGC	CCTCCTCCGC
129451	ACTGACCTCA	GTGTCATCAG	GGCTGTTTCT	CTCACATTTT	CTCACTCACC
129501	TCTCCCAACT	ACCATTGTAC	AGCAGTTGTT	CTTACATATT	GCTCCTCCTG
129551	AGGTACATCT	AGCATCGATC	ACTGGCTCAG	CTCTGGCCAG	TGGCAGCTCC
129601	CTTTTGAGGA	CACGGGACAG	CTGCTGGGCT	CTGTTCCACAG	AGGCCACTCC
129651	GGCAGACCTC	CACTACCACA	ACTTGTAGTG	TAAATCCACT	ACAACTTTCT
129701	GAGCTACAGA	AATGAAATGG	AGACCCTCTC	TGCTATGGGA	TACAAAAGAG
129751	GAAACGTGGC	GTTTAGCTCT	GGCTCACTGG	TACACCCAAC	CACAGGGTGA
129801	GAAGCAGCCT	GTTGTTATTC	ACTACTCTTA	GGACAGATTA	TGGTGAATTG
129851	TTAATAAAAG	CATTTCTTCA	TAACATCCAA	AGGAGGAAAT	ACACTAAATT
129901	ATATTTTTTA	TTAATTAATT	ACACATGCTT	AATTATATAT	GGCATGGTTG
129951	CTTTGGAAGA	ATCTTGTCCT	TACTGACCAG	ATCTGCTGTT	TGCTGAGACA
130001	AAATGGCTGA	CAATTTTGGC	CATGGTGGAT	ACCTTCCCCC	TTTTCTGTAG
130051	CATTAGGACA	GAAGTTATTC	TGGAGCCTGT	CTGACAAGTT	AGACTTGATA
130101	CCTTTAAGTA	TTTGGAAGTG	TGCTTTTCAT	GCTGGATGTC	ATCTCCAGAA
130151	CCTCCCTGTC	TGGTAAGCAG	TTCCCTGCCT	TAGTAAGAGC	CGAAACGGTC
130201	TCTCTTTTCC	TTGTTATCTC	ACCAGGATAT	TACAATGTGA	CAGGACTATC
130251	TGAACATATG	CAACCTGCAA	ATTCCAAATA	TATATATATA	TATAAGATAT
130301	CTATACACAA	ATTATTAGTG	TTTGATTGAC	ACCAGATGAC	AGAGAAAGTG
130351	ATCTGAGAAA	ACCTATTCCC	AATCTCCTTT	CTCTTTCTGC	AGACTGACAT
130401	GCATTTTCATA	GGTAGAGATA	ACATTTACTG	GGAAGCACAT	CTATCATCAC
130451	AAAAAGCAGG	CAAGATTTTC	AGACTTTCTT	AGTGGCTGAA	ATAGAAGCAA
130501	AAGACGTGAT	TAAAAACAAA	ATGAAACAAA	AAAAATCAGT	TGATACCTGT
130551	GGTGTAGACA	TCCAGCAAAA	AAATATTATT	TGCACTACCA	TCTTGTCTTA
130601	AGTCCTCAGA	CTTGGAAGG	AGAATGTAGA	TTTCCACAGT	ATATATGTTT
130651	TCACAAAAGG	AAGGAGAGAA	ACAAAAGAAA	ATGGCACTGA	CTAAACTTCA
130701	GCTAGTGGTA	TAGGAAAGTA	ATTCTGCTTA	ACAGAGATTG	CAGTGATCTC
130751	TATGTATGTC	CTGAAGAATT	ATGTTGTACT	TTTTTCCCCC	ATTTTTAAAT
130801	CAAACAGTGC	TTTACAGAGG	TCAGAATGGT	TTCTTTACTG	TTTGTCAATT
130851	CTATTATTTT	AATACAGAAC	AATAGCTTCT	ATAACTGAAA	TATATTTGCT

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130901 ATTGTATATT ATGATTGTCC CTCGAACCAT GAACACTCCT CCAGCTGAAT
 130951 TTCACAATTC CTCTGTATC TGCCAGGCCA TTAAGTTATT CATGGAAGAT
 131001 CTTTGAGGAA CACTGCAAGT TCATATCATA AACACATTTG AAATTGAGTA
 131051 TTGTTTTGCA TTGTATGGAG CTATGTTTTG CTGTATCCTC AGAATAAAAG
 131101 TTTGTTATAA AGCATTACACA CCCATAAAAA GATAGATTTA AATATTCCAA
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 131201 TTCACATGCA CGCTTCTTTA TTTCTCCTAT TTTGTCAAGA AAATAATAGG
 131251 TCAAGTCTTG TTCTCATTTA TGTCTGTCT AGCGTGGCTC AGATGCACAT
 131301 TGTACATACA AGAAGGATCA AATGAAACAG ACTTCTGGTC TGTTACTACA
 131351 ACCATAGTAA TAAGCACACT AACTAATAAT TGCTAATTAT GTTTTCCATC

NRE: A,B,C regions

131401 TCCAAGGTTT CCACATTTTT CTGTTTTCTT AAAGATCCCA TTATCTGGTT
 silencer (common site)

131451 GTAACTGAAG CTCAATGGAA CATGAGCAAT ATTTCCCAGT CTTCTCTCCC
 131501 ATCCAACAGT CCTGATGGAT TAGCAGAACA GGCAGAAAAC ACATTGTTAC
 131551 CCAGAAATTAA AAACATAATAT TTGCTCTCCA TTCAATCCAA AATGGACCTA
 131601 TTGAAACTAA AATCTAACCC AATCCCATTA AATGATTTCT ATGGTGTCAA
 131651 AGGTCAAAC TCTGAAGGGA ACCTGTGGGT GGGTCACAAT TCAGACTATA

Ovalbumin exon L

131701 TATTCCCCAG GGCTCAGCCA GTGTCTGTAC ATACAGCTAG AAAGCTGTAT
 131751 TGCCTTTAGC AGTCAAGCTC GAAAGGTAAG CAACTCTCTG GAATTACCTT
 131801 CTCTCTATAT TAGCTCTTAC TTGCACCTAA ACTTTAAAAA ATTAACAATT
 131851 ATTGTGCTAT GTGTTGTATC TTTAAGGGTG AAGTACCTGC GTGATACCCC
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 132001 TGTTTTTTAAT TTCAGAACAT CTTATCCTGT CGTTCACTAT CTGATATGCT
 132051 TTGCAGTTTG CTTGATTAAC TTCTAGCCCT ACAGAGTGCA CAGAGAGCAA
 132101 AATCATGGTG TTCAGTGAAT TCTGGGGAGT TATTTTAATG TGAAAATTCT
 132151 CTAGAAGTTT AATTCCTGCA AAGTGCAGCT GCTGATCACT ACACAAGATA
 132201 AAAATGTGGG GGGTGCATAA ACGTATATTC TTACAATAAT AGATACATGT
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 132301 CACACGTGGT CAGTAAAAAC TTTTGAGGGG TTTAATACAG AAAATCCAAT
 132351 CCTGAGGCC CAGCACTCAG TACGCATATA AAGGGCTGGG CTCTGAAGGA
 132401 CTTCTGACTT TCACAGATTA TATAAATCTC AGGAAAGCAA CTAGATTCAT
 132451 GCTGGCTCCA AAAGCTGTGC TTTATATAAG CACACTGGCT ATACAATAGT
 132501 TGTACAGTTC AGCTCTTTAT AATAGAAACA GACAGAACA GTATAAATCT
 132551 TCTATTGGTC TATGTCATGA ACAAGAATTC ATTCAGTGGC TCTGTTTTAT
 132601 AGTAAACATT GCTATTTTAT CATGTCTGCA TTTCTCTTCT GTCTGAATGT
 132651 CACCACTAAA ATTTAACTCC ACAGAAAGTT TATACTACAG TACACATGCA
 132701 TATCTTTGAG CAAAGCAAAC CATACCTGAA AGTGCAATAG AGCAGAATAT
 132751 GAATTACATG CGTGTCTTTC TCCTAGACTA CATGACCCCA TATAAATTAC
 132801 ATTCCTTATC TATTCTGCCA TCACCAAAAC AAAGGTAAAA ATACTTTTGA
 132851 AGATCTACTC ATAGCAAGTA GTGTGCAACA AACAGATATT TCTCTACATT
 132901 TATTTTTAGG GAATAAAAAA AAGAAATAAA ATAGTCAGCA AGCCTCTGCT
 132951 TTCTCATATA TCTGTCCAAA CCTAAAGTTT ACTGAAATTT GCTCTTTGAA
 133001 TTTCCAGTTT TGCAAGCCTA TCAGATTGTG TTTTAATCAG AGGTACTGAA
 133051 AAGTATCAAT GAATTCTAGC TTTCACTGAA CAAAAATATG TAGAGGCAAC
 133101 TGGCTTCTGG GACAGTTTGC TACCCAAAAG ACAACTGAAT GCAAATACAT
 133151 AAATAGATTT ATGAATATGG TTTTGAACAT GCACATGAGA GGTGGATATA
 133201 GCAACAGACA CATTACCACA GAATTACTTT AAAACTACTT GTTAACATTT
 133251 AATTGCCTAA AAAGTCTCG TAATTTACTG TTGTAGCCTA CCATAGAGTA
 133301 CCCTGCATGG TACTATGTAC AGCATTCCAT CCTTACATTT TCACTGTTCT

Ovalbumin exon 1

133351 GCTGTTTGCT CTAGACAACT CAGAGTTCAC CATGGGCTCC ATCGGTGCAG

133401	CAAGCATGGA	ATTTTGTFTT	GATGTATTCA	AGGAGCTCAA	AGTCCACCAT
133451	GCCAATGAGA	ACATCTTCTA	CTGCCCCATT	GCCATCATGT	CAGCTCTAGC
133501	CATGGTATAC	CTGGGTGCAA	AAGACAGCAC	CAGGACACAA	ATAAATAAGG
133551	TGAGCCTACA	GTAAAGATT	AAAACCTTTG	CCCTGCTCAA	TGGAGCCACA
133601	GCACTTAATT	GTATGATAAT	GTCCCTTGGA	AACTGCATAG	CTCAGAGGCT
133651	GAAAATCTGA	AACCAGAGTT	ATCTAAAAGT	GTGGCCACCT	CCAACTCCCA
133701	GAGTGTACC	CAAATGCACT	AGCTAGAAAT	CTTGAAACTG	GATTGCATAA
133751	CTTCTTTTGT	TCATAACCAT	TATTTTCAGCT	ACTATTATTT	TCAATTACAG

Ovalbumin exon 2

133801	GTTGTTCAC	TTGATAAACT	TCCAGGATTC	GGAGACAGTA	TTGAAGCTCA
133851	GGTACAGAAA	TAATTTTACC	TCCTTCTCTA	TGTCCCTTTC	CTCTGAGAAG
133901	CAAAATACAG	CAGATGAAGC	AATCTCTTAA	CTGTTCCAAG	CCCTCTCTGA
133951	TGAGCAGCTA	GTGCTCTGCA	TCCAGCAGTT	GGGAGAACAC	TGTTCAATAAG
134001	AACAGAGAAA	AAGAAGGAAG	TAACAGGGGA	TTCAGAACAA	ACAGAAGATA
134051	AACTCTAGGA	CAAAAATACC	GTGTGAATGA	GGAAACTTGT	GGATATTTGT
134101	ACGCTTAAGC	AAGACAGCTA	GATGATTCTG	GATAAATGGG	TCTGGTTGGA
134151	AAAGAAGGAA	AGCCTGGCTG	ATCTGCTGGA	GCTAGATTAT	TGCAGCAGGT
134201	AGGCAGGAGT	TCCCTAGAGA	AAAGTATGAG	GGAATTACAG	AAGAAAAACA
134251	GCACAAAATT	GTAAATATTG	GAAAAGGACC	ACATCAGTGT	AGTTACTAGC
134301	AGTAAGACAG	ACAGGATGAA	AAATAGTTTT	GTAAACAGAA	GTATCTAACT
134351	ACTTTACTCT	GTTCATAAC	TACGTAAAC	CTACTAAGTA	ATAAACTAG

Ovalbumin exon 3

134401	AATAACAACA	TCTTTCTTTC	TCTTTGTATT	CAGTGTGGCA	CATCTGTAAA
134451	CGTTCACTCT	TCACTTAGAG	ACATCCTCAA	CCAAATCACC	AAACCAAATG
134501	ATGTTTATTC	GTTTCAGCCTT	GCCAGTAGAC	TTTATGCTGA	AGAGAGATAC
134551	CCAATCCTGC	CAGTAAGTTG	CTCTAAAATC	TGATCTGAGT	GTATTTCCAT
134601	GCCAAAGCTC	TACCATTCTG	TAATGCAAAA	ACAGTCAGAG	TTCCACATGT
134651	TTCACTAAGA	AAATTTCTTT	TTCTCTTGTT	TTTACAAATG	AAAGAGAGGA
134701	CAAATAACAT	TTCTCTATCA	CCGACCTGAA	ACTCTACAGT	CTTCAGAGAA
134751	TGAATGGCTT	GCTAAAAGAA	TGTCAAATCT	TACTATACAG	CTATTTTCATA
134801	TTCACTACT	AAATACACTA	TAAGGCATAG	CATGTAGTAA	TACAGTGTA
134851	AATAGCTTTT	TACACTACTA	TATTATTAAT	ATCTGTTAAT	TCCAGTCTTG
134901	CATTTACAT	TTGCAAAACG	TTTTGAAATT	CGTATCTGAA	AGCTGAATAC

Ovalbumin exon 4

134951	TCTTGCTTTA	CAGGAATACT	TGCAGTGTGT	GAAGGAACTG	TATAGAGGAG
135001	GCTTGGAACC	TATCAACTTT	CAAACAGCTG	CAGATCAAGC	CAGAGAGCTC
135051	ATCAATTCCT	GGGTAGAAAAG	TCAGACAAAT	GGTAAGGTAG	AACATGCTTT
135101	GTACATAGTG	AGAGTTGGTT	CACCCTAATA	CTGAGAACCT	GGATATAGCT
135151	CAGCCAGCGT	GCTTTGCGTT	CAAGCTTACC	AGAGCTGTTG	TATGCCTGTT
135201	AAGCAGGGCA	TACAGTCATG	AGGCTCTTGA	AAAATCTTAA	CAGACAAAGG
135251	GCAATGGAAA	ATCGGAGTTA	AGGGATGGTA	GGGATAAAAT	GCATAGAAAG
135301	AGGTACCACA	ATTTTGATTT	TTGCCCTAAT	GCCTCTCTGC	GTGGTTCCCTC
135351	AATTTTTTCTA	CTTCATTCCCT	CATCTCCTCA	GAGCATTCCT	TTCCCTCATG
135401	CTTGAAACAC	AGATGAAAGA	CTGTGAATTC	TAACTGAGAT	GAAAACATCC
135451	ACAACCACAC	AACCTCTGGT	GTGGAGTCAC	ATTCTGTGAA	GGCAAAAACCT
135501	AGGCCACGTA	ATCTATGTGT	GCAAGCTACG	TGTAAGCTAT	GTGTGTGACA
135551	GGACAATGTG	AGGAACATAC	TATGTGCACA	AGGACTGCAG	AATAAACAGG
135601	AGCAAAGTTT	TTGAAGAAAA	CAGAGTAAAA	TCCTGTTTTT	CTCTTTTGT
135651	ACATTCTTTA	CATATATCTC	AAATTTCCCTC	TTTGGTTAGA	AGCAAGTAAT
135701	ATTTATGTTT	CTTGGTACTG	TTTGGGTTGA	AGACCATTC	GGGATAAGAG
135751	AAATTCCAGT	GGTTCTTCCC	CTAATCATAA	AATGTACAGG	TTTAGTTT
135801	TTGTAAACACA	GAAATCTCTT	CATCTTTTAT	CTTTTGTGT	GATTCTTTAT
135851	AGAGAGAGAA	ACAAGACTTA	CTGACAATAG	CAGCAAGAAA	ATCAATCTTG
135901	GAAGAACAAG	ATTGCAGTTG	CAAAAACAAA	CCAATGTCCT	TGCCCTTACA

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135951 TCCTCTTCCC CATAAATTCT ACATTCTCTA TCTACCTTGT GCTTGCCAAC
 136001 ATGATATACG TAAACTCTCT TTTCGTATTC ATTCTTAAAG GAATTATCAG

Ovalbumin exon 5

136051 AAATGTCCTT CAGCCAAGCT CCGTGGATT CCAAAGTGCA ATGGTTCTGG
 136101 TTAATGCCAT TGTCTTCAAA GGACTGTGGG AGAAAGCATT TAAGGATGAA
 136151 GACACACAAG CAATGCCTTT CAGAGTGAAG GAGGTATATG GGCATACCTT
 136201 AGAGATGTAA TCTAGAATTT ATGAAGAGAG TAGACATGTT GTTATATGAA
 136251 CACTGCATTA GCGTATCTGC TCATTTGTCT GCATCTCTTT CAGACACTGT
 136301 GTTAAAAGCA GGAATTTTC CTTATGTCTC TCTCATCACA ATATTCCTGA
 136351 CATTGCAAAG CTCCTGAGAA ATAACCTCAG ATTCCCACTT TTCCTAGGAA
 136401 GGTCTTCCTG GATGAGAACAA ATCAATCATC TTAACGTGAA CTAGATATTT
 136451 CTGCATCTAA GAATAATCTT TGTAAAACT ATATTCTCTC TCTCTTTTTT

Ovalbumin exon 6

136501 TTTTTTTTTT GGTTCTCCAG CAAGAAAGCA AACCTGTGCA GATGATGTAC
 136551 CAGATTGGTT TATTTAGAGT GGCATCAATG GCTTCTGAGA AAATGAAGAT
 136601 CCTGGAGCTT CCATTTGCCA GTGGGACAAT GAGCATGTTG GTGCTGTTGC
 136651 CTGATGAAGT CTCAGGCCTT GAGCAGGTAT GGCCCTAGAA GTTGGCTTCA
 136701 GAATATTAAA AACACATGGA AATTTAGCTG TTGTAAAGCT CTTTTCACAA
 136751 CAGTTATCCT AAAACATTTA ACCAGCACAA ATTTTCATCAT GATTCATAT
 136801 GTGATTGTTG CATAGAAGTG TAGATTTGTC CCACTGGGTC CTGCAATAGC
 136851 CCATGCTGAG CATGGCTTGC TGAAAGAACT GCTTTAGAGG GTGAAAAGTT
 136901 TGACACAGCA GACAAGATGA TTCTCACCTA AGCAGCTGTT ACTGTAGTGG
 136951 CTTGAACTCT AAAGGTCTTG TATCTCCATT CCTGTGCACT GAGGAGCTTC
 137001 TTGGAAAGTT CATATAAGGT TTAGTAGTTC TAACTATTAT CTCATTTGGT
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 137101 TTGGATGTGG TTAAAGCAAT TTCAGAAATA ACATGTACAT AATGTACAAT
 137151 TATTGATATG AACAGAACAC AGGCATAGCA TATTGTAAAT AGGAGGACTG
 137201 TAGTTATTTT GAATAGGAAA CACAATGTAA TAAATGAGAA TTCATTGAAA
 137251 TGTAGTATG CTAATCAAT CTAAATTATA AAGATAAAGA GGCATTTAAT
 137301 CACAGCTAGA TTTCCATCAC TTGTGACAGA CAGGCATATG AATGATTATG
 137351 TACAGCTCTA GGAAAAAAG TATGTAGGAA AACTAGTACA TTTTGATTAG
 137401 AAAGTCTGAA AATGAGGTGC CTTGATCAAA GAGAATACGT GTGTTTGAGA
 137451 AAAAAAAGT TTGGATAGAG GTGGTAAGAG AGAATATATT GAAATGGTGT
 137501 TTCTACAAAC TGCCATGGCC AGATTTGTGT AAGAGACATT CAGTAAGTAG
 137551 GCAAGGAAAG AAATATTACT AGGTACAAAG CAACATTAGT AATACCAAAA
 137601 GAAACCAATT ATTCCAGATG CCAATCTCGT AATAGGGTTA AGAGATTTCC
 137651 ACCCCTCTAG TAGTCACCAG TGCAACCAGT AACTTTGCTA ATTTACATTT
 137701 TCTTTTTTTT AATGGCAGAT ATAGCTTTGA ACTGAGTGAT CATGAACTGG
 137751 TACTGTGTAA ATAAGATGGA AGCATACTTG GGAGCTAAAC TTCTAGTTTT
 137801 TAAAACTCA AATTCTCTTG AAAGATCAGT TCCAGTCTA GTAACAGCTG
 137851 ATAGTTTAAG TATCAGTAAT TGGCTACCAT TAACAACTGG CTCCTGAGAG
 137901 GTCTTAAATG TAGAGACAGC TTTAAACTCA AAAGCACAGA GTGATTTTTA
 137951 GAATAGATTT CCCAAGCAAA GAAAATAAAC AGGGAGGAGC TTTAAGGGAG
 138001 TAGCCATCTC ATTATTATTA TTATTTAAAG AAATGGCAGC AAGGCTATAA
 138051 AAGAAAAATA AGACAGAGCA GAGAAGAAAG AGTCATGGTA TGCTTTTCTA
 138101 TCTTAGCAAA ATTAATCTCT ACATGCCTAG GAAAAAGCCA TGACAAGAGC
 138151 AATCAGTTCA AAAGGTGTAT GCAAAAAAAC ACATAATAGT AACTAGTACT
 138201 GCATTGCCAG GAAGGAAGTT ATGTCGCCAT TCCATGGATC TCATTCTCAT

Ovalbumin exon 7

138251 TTCCTTGCA GCTTGAGAGTA TAATCAACTT TGAAAACTG ACTGAATGGA
 138301 CCAGTTCTAA TGTTATGGAA GAGAGGAAGA TCAAAGTGTA CTTACCTCGC
 138351 ATGAAGATGG AGGAAAAATA CAACCTCACA TCTGTCTTAA TGGCTATGGG
 138401 CATTACTGAC GTGTTTAGCT CTTAGCCCAA TCTGTCTGGC ATCTCCTCAG
 138451 CAGAGAGCCT GAAGATATCT CAAGCTGTCC ATGCAGCACA TGCAGAAATC

138501	AATGAAGCAG	GCAGAGAGGT	GGTAGGGTCA	GCAGAGGCTG	GAGTGGATGC
138551	TGCAAGCGTC	TCTGAAGAAT	TTAGGGCTGA	CCATCCATTC	CTCTTCTGTA
138601	TCAAGCACAT	CGCAACCAAC	GCCGTTCTCT	TCTTTGGCAG	ATGTGTTTCC
138651	CCTTAAAAAG	AAGAAAGCTG	AAAAACTCTG	TCCCTTCCAA	CAAGACCCAG
138701	AGCACTGTAG	TATCAGGGGT	AAAATGAAAA	GTATGTTATC	TGCTGCATCC
138751	AGACTTCATA	AAAGCTGGAG	CTTAATCTAG	AAAAAAAATC	AGAAAGAAAT
138801	TACACTGTGA	GAACAGGTGC	AATTCACTTT	TCCTTTACAC	AGAGTAATAC
138851	TGGTAACCTCA	TGGATGAAGG	CTTAAGGGAA	TGAAATTGGA	CTCACAGTAC
138901	TGAGTCATCA	CACTGAAAAA	TGCAACCTGA	TACATCAGCA	GAAGGTTTAT
138951	GGGGGAAAAA	TGCAGCCTTC	CAATTAAGCC	AGATATCTGT	ATGACCAAGC
139001	TGCTCCAGAA	TTAGTCACTC	AAAATCTCTC	AGATTAAATT	ATCAACTGTC
139051	ACCAACCATT	CCTATGCTGA	CAAGGCAATT	GCTTGTTCTC	TGTGTTCCCTG
139101	ATACTACAAG	GCTCTTCCTG	ACTTCCTAAA	GATGCATTAT	AAAAATCTTA
139151	TAATTACACAT	TTCTCCCTAA	ACTTTGACTC	AATCATGGTA	TGTTGGCAAA
139201	TATGGTATAT	TACTATTCAA	ATTGTTTTCC	TTGTACCCAT	ATGTAATGGG
139251	TCTTGTTGAAT	GTGCTCTTTT	GTTCTTTTAA	TCATAATAAA	AACATGTTTA
139301	AGCAAAACACT	TTTCACTTGT	AGTATTTGAA	GTACAGCAAG	GTTGTGTAGC
139351	AGGGAAAGAA	TGACATGCAG	AGGAATAAGT	ATGGACACAC	AGGCTAGCAG
139401	CGACTGTAGA	ACAAGTACTA	ATGGGTGAGA	AGTTGAACAA	GAGTCCCCTA
139451	CAGCAACTTA	ATCTAATAAG	CTAGTGGTCT	ACATCAGCTA	AAAGAGCATA
139501	GTGAGGGATG	AAATTGGTTC	TCCTTTCTAA	GCATCACCTG	GGACAACCTCA
139551	TCTGGAGCAG	TGTGTCCAAT	CTGCCGCTGC	CCTGATCCTG	GCTGGGGTGA
139601	TGGGACAGAC	CTTGGCTGCC	ACTGAGACAT	CTGAGACACT	GAGATCTGTC
139651	TCAACTCAGA	TTTACCCAAG	AACAGATCAT	TGCCAACAGA	ACAAAATCTC
139701	AAACTTATGG	CTAGTGATGA	CAGCAGTCAG	TTGTCCCATC	TGTGACCCAC
139751	CAAGGCTGGC	ATGCTGGAAT	GAGCAGGCTT	TGGTGGCTTG	TAGTTACTGG
139801	ACAGCACCAC	TGACATGGGC	AGGGGAAAAA	CTGAGCATGG	TGTAATCAGC
139851	TGCCTCAAAG	CCACTTCTCT	GTGCCGTCAC	CATGCTTGAA	AGCTCTTCTA
139901	CAGGAGCTGG	GTTTGTTCAA	GAAAGCTTCT	GTTTCTCCCA	TCTGCTTCTT
139951	GTACCTTCAC	AGGGACAGAG	TTAGAAGGGT	ACAGCCATGG	CTGGAAGGGG
140001	CTGACTTTCA	AATGTGCCTA	ATTTTCCTTT	GGTTGCTGCT	GCAGCTGCAG
140051	AAGAAGGGGT	TCAGAAGCCA	AGAGCTTTGA	GATAAGGATG	CCTAACCTAT
140101	GTTGAAGACA	TTTGTGCTGA	CACCTCAGGC	CCCAGGATAG	GACAACTGCT
140151	GGATTGTGGC	TAACCCACTA	GCTACAGAAC	CTAATTTATA	TTACCAGATT
140201	AGGAAGAGCA	AAAGAACATG	TATTTATAAC	AGGAGGTCTT	CTGTGCTTCT
140251	CTACTAAAAG	GTGCTGTGAA	GGAGCCCA	GTGCAGCAGT	GTATGAGGCC
140301	TGAAAGAGGC	CGCAGCACAC	GAAGAGCCCT	GGTAGGAGCA	GCACACAGAG
140351	GGGACAGGAG	GCTGGGGGAA	CTGCCACCCA	TGGGGACCTG	TGTGAAGCAG
140401	TGCACTCCTG	AGGGGTGGAC	TGCGTGGGAA	AGGAAAAGAA	AGCAAAACAGA
140451	CCTGTGATGA	ACTGTCACAC	AGACTGCAGA	GTGACAGAGG	AGGGCTTGAG
140501	GCAGTGCCTG	TACTGCAGGG	AGTGGCGCTC	CTTCCTCACA	GCAGCGCTAA
140551	CAGCTTGGCA	CCAATATTCA	GTAGTCTGTG	GTGATGCTTT	TTCCAGTTTC
140601	ACCACACAGC	ATTTGCTTGG	TTTACTTGT	TTTAGCTTTC	CCCCTCCACA
140651	AGATAACACA	TACTTTGCCA	GTCAGTCCCT	AAGACCTTAG	CCTAACAGTT
140701	AGCAACAGG	ATCTTGCAAA	AGAAGGAAGA	TAACATGACA	CCACCTTCAC
140751	TGGTGTATAA	ATAGTTCAAA	TACTTTCCTT	CACTTTCCCG	TAAATTAGTT
140801	GATTGCAGGT	CAGGAGATAA	CAGGGGAAC	TACTGCAAGA	GAGAAAATGA
140851	TGTTTAATAT	TGTCTTGGAC	TTTCTGGTGG	TCTGGGCATG	AAAATGGAGT
140901	ACTCAAAATC	CTCAGGACGT	TTATTTTTC	CCTGATTTAT	TCCCAAACCTG
140951	CACTATTTCT	AGGCCATTGG	AGTTCTTATC	AATTAAATTA	TACTTTGGCT
141001	CTCTGCTATC	TCACTCCCTT	TCATCTTCAG	CATCACTTTC	AGCACAAATTA
141051	CAGGAGAAGA	CTTAGACTCA	GAGCTTTAGG	ACTCATCATA	AGAGGCTTTC
141101	ATTGCTCTGT	CACCACACCC	CATATAGATC	TGTAGTATAC	CACACATGTG
141151	AAGAAGCACA	GTACATTAGT	GCATTACAGA	GAGACAAAAC	CACACCTATT

141201	TGTGTGCCTG	CAGTCTTACA	CCAGCAGGAA	GATAATTAAC	GTAATGAATT
141251	TCTATAAAAA	TGAGAGAATA	TGGCCCCTGG	GTCCTACTGC	TTGTTCTAGT
141301	CCTGATTCTT	CAAACGTAAG	AATGCAAGTA	AAATTACTCA	CTTGAACAAA
141351	GTCAGCAATT	TGCAAGAACT	GATATTCTGA	AGTTCAAGTA	ATTAGAGTGA
141401	TTTCCAGTAC	TTCTGGCTGG	AACGGGCAGC	TGAAAATCAC	CTGGTCCAGC
141451	ACCTTGCTCA	AAGCAGGACT	ATCTTCAAAG	CCATATCAGA	TAGCTCCAGA
141501	CCTTCCCTAG	TCAAGTGTTG	CCTATCTGCA	TGGTTGGAGA	ACCCACAGCC
141551	TTCTGATTAA	TTTGATTTTA	AACATAAATT	CAAATGTCAC	TAGCGTAGCA
141601	GTAGTGAAAG	CCATTCAACT	GGCTTTACTT	TCTCTTACCA	AATGAGAGTT
141651	AGCTGCAGGT	GAAAATAAGC	CCTGCCAGTT	CTCATTTTTT	CTCCCACAGC
141701	CCACAAAGCT	CTCACTGTCT	GTCCTCACTT	GTAATACTTT	TGAACCAACA
141751	TCTACAGATT	ATCTCTGTAA	ATCCCAAGCA	GTACCTAGTC	ACCACGTGAA
141801	CAACAAATTC	CTACATTTAA	CAATATTTAA	GAGCAAAGGC	CAGACCATAT
141851	GTAGCTGCAC	ACTACACATT	TTTAGACCCA	ATAGTATAAT	TTTACTTTTG
141901	ACTCCATGTT	GCTGCCATGT	GGATAACAAT	GCGCAATCAT	TTGTACCTGG
141951	CTTCCTTTTC	TAAGTAGTAT	ACTCTTAAAC	GTCACAAGAT	AAAGACTCTA
142001	GTTCTGTATA	GTCTAGCTGA	CTTGTGACAA	GAGCAAACAC	TCACAAATTC
142051	ATGGTACTCC	TGAGGAAAAA	AAGGATCCCA	AACTAATTTT	GAGCTTTTAC
142101	ATATTTTTTT	TTAACCTACA	GAGCACCTTG	CTACTTCTGC	TGAATGTTAG
142151	CAATAGCAAC	CCACAGTCTG	AAATCAATGC	AATGAACTTC	TACTATGGGT
142201	ACCATACTGA	TGACAGGAAT	AGTGCAAGTC	CTTACACTGG	AAGGCTGACT
142251	CCTTAGTCAC	ATAGGTAAAA	TTTAGAAATT	GCAGCTCTGA	TAAGAGATCA
142301	GTATGGGAAA	GGGAAAATAA	TGGGGTGCCA	GATGAGTGCA	CCTTCCTGAA
142351	AGGAAGGCAG	ATATATGGGA	ATTAAAGGTG	GACAAGGGAT	GCTGTGGAGG
142401	TACCATCAAC	TTTCACAGGG	CTGTATGTAA	AAGCAGCTCT	CTTTCCTGTT
142451	GATTCTCCGC	TGCCTCATTT	CTTCTGGGCA	AAGTTTGTTA	CTCTCCAGTA
142501	ACGTCCCTTC	CTCAAACCTG	TACCTAATCC	CACCCTCAT	GCCTTCTCTG
142551	TTTTGCTCTG	TCCTTCAGCA	GTCTCTACCT	GCTTCTTAAG	GTATGTAAGT
142601	AAGAGGGCAG	TTCTGGAGTC	AAGCTCTGTT	TCTATGAGGG	TAAAGGCCAG
142651	GGAGAGAAAG	GTTTGGGAGT	GTGAGGAGAG	CCTTTTTTCCT	GTGTTGTTCA
142701	AGTACTTAGT	CCAAGCTGCT	TTCAGCTGCA	TCTGCAGAAG	ATGGGGGAATG
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142801	CCTTGCATAC	AGTATACTAG	CTTTCCTTAG	TCAAATGTTT	CCTCTGTGCT
142851	GCAGAGTCCA	AGGTAAAGAG	GCTTTGTCTA	CAGCTAGGTC	TATGTTTCTA
142901	GAGAAACAAT	TAGCAACTGC	AAAATCAAGA	GGTACTAAGA	AAGCCTCTGA
142951	AGCTATACCC	AGGGGTCTGG	CAAATGAAGG	GGGACAGATC	AAGAAGAAAG
143001	AAGAGTCTAG	AGCAGTTTAA	GGGAATAATG	CCACTAGTTT	TAAGCCACAC
143051	ATCTGGTGGT	AAGCTTTTAA	CTTTGAAAGA	GACAGAAATC	TCAAGATACA
143101	CCAGCCCAAA	ATATAATGGA	GCCATAAAGG	TCTGCACGTA	GCTGAATCCC
143151	AACTGGAAAG	AACAGCTTCA	AAGAGCTTGG	AAGTGCTGAG	GTGAAGAAGA
143201	GCATGTGATC	ATTAGATTTC	AAAAGAAGGT	CCTCAGCACA	ATAACCAGAA
143251	AGTTCACCTT	TCTGTGGGAC	AAAAGATGCG	TCCCTCACAA	AGGCTGGGGG
143301	AACAAAATCT	TTGCATCTCA	TTTTGCCTGA	GAGGAGAAGG	AAATACAAGA
143351	TCATCTTGTT	TTACTTGGTG	TGTATCACAT	CATTAATTTT	TATTTGGTCA
143401	CTACTATGCA	GAACCTGCTA	ACTTGAACCA	TGTAAAAAGC	ACACTAGGTC
143451	TCAAGAGACT	AAAATGCTTC	TTGCAACAGG	CAGAGTGTGA	GAGATGGAAG
143501	GATGGAAAAA	TCTTGCAGTG	ATGAAGGCAC	TGATAAGAGA	TGTTGAAATG
143551	ATACTAACAA	ATGGCACTCT	ATCTTTCCTA	AGATCTTTGT	CAGCATGAAG
143601	GGAAAATTCT	ATTCCAAGCT	CTCTTTGAGG	GGTTACCATG	TTCCAGGATA
143651	AAGACTTGCT	GCATACACAA	GCGCACTTAG	TCAGGTCACT	CAGATCAGTC
143701	TCATGCTAAA	AAGTGTGAAA	ATAGAAATAC	AAATAAGGGG	CCAAGCAGAT
143751	TACTGAACAG	CAAAGATTGC	CAGTACGTGT	CCACAATGAG	TATTTGGACA
143801	TTTCACTGCC	GAAACTTCTG	AAAATATCAA	CTGCCTTATG	AAACTCTGGT
143851	TATTCCACCG	CACAGGAGTA	TTTGTGGTTG	AGCTGCATGA	AGAAATAGCA

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143901 AGTGTTTAA CTGATTTCCT AAAAGAGAGC CTTTCCTCTA CATGCTGCTC
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145101 AATGGTTTGG ACATTTAAAG TCCTTTCATG TTTAAACTT ACTGGCCTGC
145151 TCTGGCTGAG ACAAAAACAC GAGCAGAATG CTCTGTTGGC TGAACCAGAA
145201 ACCATTCCCC CCCAGATAAA TAAACAGCAC TTTTACTGGT AAAAAAGAT
145251 ATTAGAAGAT GCCAAAGAAA TGGAGTAGCT TTTCTTCAAG CATAATTTTT
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145751 CAAACATAAG ACTTTGAGCA TGTGGAGTG TTGACTTAGT AGAGAGTGGG
145801 AGTGAGGGAA CCGCTGCTCC TGAGTCAGCC TCAGCACCGC CCATTGAACT
145851 CTGTACCTCC TAGCCTTGGT AACTTCACAG GATGCTGGAA AATATTATCA
145901 AGTCATCACA TTGATTATTT GAATATCTTC CTTTATAGATT TTAGTTGCTT
145951 TGTATGTATT TTTTTTTCCA CTAATAACCA GCCATGCTAT TCAAAAGGCA
146001 TTTTAAAAG GCAACGTTAA CACCCTGTAC AAACACCATC CTCTCATTCA
146051 TTCAAATCCC ACATTTCTGC ATATATGGAA CATGTCAGTC ACTTCTTGTA
146101 ACAGAGCAAG TACTATGACT AGTCAGCAAA TTAAATTCAT CCCTGCTTTA
146151 AAAACAGAAA ATCCAAGTAA CTGCTCCAAG GGATGAAGTT TATTTAGTGT
146201 ATCTATCATT TGTTCTACAA CACAGTTAAT TTTGCAAAGA TGACTCAAAT
146251 CATTTAAAGC TTTGGAAATC ATTTAAGGCC AATGTAAACA GATTACAAC
146301 TTCCCAGGCG CAATGGAAGC AATTAATTCT GCAGCACACC TCTCCTACAC
146351 TACTATACTC TGGAAAACGT AACAGATGCA TCTAATTATA ACCCACACTG
146401 AAACATGCTG TCTTTATGTA GCTATGAATT CAAAACAGCT GAGGGGACAG
146451 AAAGAACCAT CCTCCTAAAG CTATGTGGCT GCTCACCTGT AGGAAAGCAA
146501 CTTTCAAGAAA GCTTTGAGTT CCCAGGTTAC ACTGATGCAG AAGCTTCACC

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146551	ACTGGCAAGG	TGCTCCTTGT	GTGAGCAACC	TATTCTGCTC	TATAAAACAT
146601	TTAGCAGATA	ATCCCATATC	TCAGTCCTCA	GTACAAGAGA	CTCTGTGCCA
146651	GCCACTTCTG	TACGAAATAA	GCCCACACGT	ACTTTCATAG	ACCTCAGGGC
146701	AGAAGAAAAG	TTTCAGAAAAG	CAGTTTGTGC	TGAGGAGATA	GACCTTGGGG
146751	GTGAGTCTTT	CTCCATATTG	AGGCGGAATC	CCTCAAAGAC	AAGCAGCCCT
146801	TATCCAGGTG	TTCAAGGTGA	TATTTTCAAC	AGAGCAGGGA	GGTAAAGAAT
146851	GAAATAAAGG	GCAGAGTTAC	ATAGGATTTT	TCAGTCAGAG	GTGAGAGCTG
146901	AGATGGACAG	GACAATGAGG	TAAGGACAGT	GTGACTGTGA	GGAGAATTAG
146951	CGATGGAAAT	GCTTCACTAG	CCAAGGCAAG	AAGAAAAAGA	GTATTCAATA
147001	GAATATCAAT	TTCTGGGGAA	AGAATTCATC	TCTGAAGGGC	TACATAGGGC
147051	AAATAGCTGC	TTTCAACTTA	GAACAGGGAA	ACTGAGGCAG	CAGCAAAAAA
147101	AAAAAAAAAA	GTCTAATCTG	AAACCCACAT	CAGGTTCTAC	TGTTGTTGCA
147151	GTGATAAGAA	AAGTGTCTGA	TGAGTGTTC	TCAACCTTCG	TTATCTCACA
147201	GTGAAAACAT	TTTCCTGGTT	ATACAGTTTT	AGAATCCTCC	AATATTACCA
147251	AAAAATCATT	TTACTAAAAA	TGGAATCCCA	CAAGAAATGA	CTAATTTTTT
147301	ATCTGTAGGA	AACGGACAAT	AGAAAACTC	ATAAAATATGA	TGTCACTGTC
147351	CTTTCGCTGT	CTCTTCCTTG	GAAATTGTTT	CTATTAGAGG	AATCATAAGT
147401	AGGTCAGCTA	CTGCATTTTT	TTACCCTCCA	AATTGCAAAA	GAAATGTTGT
147451	TTCCAGCAGT	GATGGTTCAA	GTTGTAACTA	GCCTGTTGCC	ACAAAAATGT
147501	TTATAGAAAT	ATTTCTGCAG	TCAGTTTTGT	AAGGTTCTTG	TATGGTATCA
147551	CTCTCACCGT	CAC TTCACAT	CCTACTCTGA	GATGATTCAG	TTCTTCCATA
147601	GGGATGTGGC	CTTCAGGGCA	AAATAAATTG	CAGAGTCATG	AGTCATAAGA
147651	ACCTTTGAAG	AACAGGCCAG	GCAGACTATA	AATTCAGCCT	ACCCATCATC
W gene exon L					
147701	TGAACTGCAT	AAACCTTGGA	CAGACCCAGA	GCAGCAGTCT	TCCTCCCTGC
147751	ACAAAAACAAG	GTACTGTAAT	TATTTCTAGA	GATTATTTAT	TTCACCTACT
147801	CTTGGATGAT	GTCGATCTGT	TGACAAATGC	ATAGAAAAAA	AAGGCAGAAG
147851	GAATCTGAAT	AGAAAACAAT	AAATACTTGA	GGAAGAAATT	TACTAAGATG
147901	GCACAGGCAA	GGTCTAGAAG	GGGTAAGTCT	CAGAAATATG	CAGGAAGAGT
147951	GGTTTATTCT	ATGTAGTTCT	CACTGGCAAA	CATGTATATC	ATAGCAGAGT
148001	AAGAACCATT	GTGTTTGCTT	AAGTTAGATC	ATTTGTTTCT	GTGCTCTTCA
148051	ATTCTTGTTG	ACGTCAAGAC	ACAGTCAGTA	CATCTTTATT	TTATGGCTAT
148101	TCTGTATCAA	CCAGAATAGC	TCCCACTACA	TACCTAGGGC	TCTCAGCTTC
148151	AACTGCAATG	CAAATAACAA	AGAGCAGCAC	CTGTGTTCTA	CCAATAAGGA
148201	AATTTGTCTT	GCAGAACTGG	GAAGCTATGA	TTCGGACTAG	CACCATAAGA
148251	CAGAGTTTCC	AGAAATTTTT	GAAAGTTAAA	AATGGAATTC	AGGATACTTA
148301	GCACACAGTA	GTTAGAGAGC	TGCTTGTTCTA	GTGCTTCAAT	ATTTTCTTGT
148351	ATCCTAAAGG	AATGGAATAT	TTGTTCACTA	CAGTTACGAG	CTCCAAAAGG
148401	CTCTTGACAC	AGTAGTCATA	AGAAACAATC	TCTCAGCATC	TTCTAGCCCT
148451	CGCACCAGTG	AGTAGCATT	TCATATGTCA	CTCCAAGATG	CTGTAAAGGA
148501	CAGTGCAATA	AACGTCCTGA	TGAACAAATA	CAAAATGAAA	TATGAGGCTG
148551	CTTTTCTTAT	ATCACTTGAG	TATGGTTAGT	GTGTTGGTG	AAACGGGATG
148601	CAC TATACTT	AATATAACTT	TTTAGTAGCT	AATCTTCCTC	ATTTTCCATA
148651	AAGATATCTC	TCTTCTTTCC	ATCTGTAAGT	TCCTTACCAT	ATCATTATAT
148701	TGCTTACATA	GAATTCACCA	TATAGTTATA	AATTGCATGC	TTTTTCTTTT
148751	TAGTATAACA	CTGTAACCAT	CCTGTTTCGA	TGAATTTTCT	TTTGTTTCTC
148801	CTGGCTGTCC	CTTGCATGGA	TATCTGTCTT	TCTAAGTGAA	CTTCTGCTGA
148851	ACCAAGGAGA	GTTCAATTCAT	GCACTACAAA	CAGACGTAGT	TGGCAGAAAT
148901	GAATATTGTA	CCAGTACTGA	CAGGTCAGAA	TGCTTTCATT	CAGTTTCCTG
148951	AGGTCAGAGG	AGAGCTGAAG	AAAATACCTG	GCACAGTCTA	GATTTTGCCT
149001	TTGAACATAC	ACTGCCAGTG	AGCCTCAGTC	ATACAAAGGA	TCAGTGTGCT
149051	GCACTGGCAT	TCTTCCACAG	TCAATAAGTG	TTAAAAATAC	TTT TAGAAAG
149101	CCTACAAATC	ATAAAATAAA	CTTCAAATAC	TGAAAGGGAG	CCTGCAGACA
149151	TATAGCAAAC	ACAATTAATT	CTTAGCTAAT	AACATCTTTT	GTCCCTTTCT

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W gene exon 1

149201 GCGCAGGTTT AGAACAATGG AAGCTTTTAAA TAAAGCAAAC ACAAGCTTTG
 149251 CTCTTGACTT TTTCAAACAT GAGTGTGAGG AAGATGACAA CAAGAACATT
 149301 TTGTTCTCCC CTCTCAGTAT TTCATCTGCC CTGGCTACTG TGTATCTGGG
 149351 AGCCAAAGGC AACACTGCAG ATCAGATGGC AAAGGTGAGT CTGAGAAGAG
 149401 TTGATCTACT GGAGTAACAT TCTCTATGAT AGAAATTTAG CATGATGCAT
 149451 CAAAGGAAAA CCTTATGCAG GTCAAAAGAT ACAGTCTACA GTAGCTTCTG
 149501 TAAGCAGGCC CACACCAAAT GGGAGCAGTG GCATTAGTGA CATTGTCCTC
 149551 TTTTAAATGT CATTGGAAAG AAGAAGAGCT CTTAATCCCA AAGCTCAATA
 149601 ACTTGAGCAC TCACCAGTGA GAGGGAGACT CGGATTCTCC ACCTGCCTTG
 149651 CTCCAGAAAA TTCTCATTTT CTGTCTCATC TCTCTGAAA TGGCCCTATG
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 149751 AAATCTACAA ACCCACAAGG TCAGAGAAGA AACACAGTCA GGGTGATAAT
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 149851 GTTCCTAAAC TCTGTGCAAA GTTCATAGCT TCAAAAAGGCA GCAATGAGAA
 149901 CAGCCCCAGT GCAAACATGG TTACCTAGCA TGTACTGCGG GAGGGGCTGA
 149951 TGAAGTGGCA TCTGCTAAGG CAGAAGAAGC TGCTCCACCT GCTAAGGCAG
 150001 CAATCCAAC TCTGAGCTAC AGGACAAATG AGGACCAGCA GGGTCACAAA
 150051 GAAAGGAGAG ATCTTCTGTC AGGAAGAAGG GAAAACAAAA CAAAACAGAA
 150101 GGCTTTTGAA AAATGTTCCA AGGTTAGATG TACACCTCTG TAGCCTGGGT
 150151 AAGGTGCACA TGCCAGAGG AAGGCATTTA GGGTATCAAT TTGCTCCAG
 150201 TGTTTACCTG CTTTCTGACA TGTACCAGGC TCTCCATTTT ACACCCATGC
 150251 TTTGGCAGTT TCCACCTGCA GATAACTGGC CCGTCCCAGG TATTACCCTA
 150301 TGAGTACAAG AGCCGATTTG AAGCAGGCAA GTTCCTCTAG AAATACCAGA
 150351 TATATGAGAA TTCTGCTTGC AGCCCTCATC TTAGTGTGCT CAAGACATCC
 150401 TGTACACATG GGCTCAAAAG TAAATCTGT CTTTGTCTCT CTTTCATCACC
 150451 AGTCCCATGA CATTACTGAA AGTTTTTACT GAAACAGCAA ATTTTCTATC
 150501 ATTGCATTTA TTAAGTCAAT TTCCACTGCA GGTACTCTAC TTCAACGAAG
 150551 CTGAAGGAGC CAGAAACGTC ACCACAACCA TAAGAATGCA AGTCTATTCC
 150601 AGAACAGATG AGCGCCTATC AAATCACCGT GCCTGTTTCC AGAAGGTATA

CR1-d

150651 TAACCAAGTC TAATGATCAT AGAATCATAG AATGGCCTGG GTTGAAAAGG
 150701 ACCACAATGA TCATCTAGTT TCAATCCCCC TGCTATGTGC AGGGTCACCA
 150751 ACCACTAGAC CAGGCTGTCC AGAGCCACAT CCAGCCTGGC CTTGAATGCC

MAR (0.852)

150801 TCCAGGGATG GGGCATCCAC AACCTCTTTG GGCAACCTGT TCCAGTGCCT
 150851 CATGATCAAG CTACAGTCAT GCTAACACCT TCCCTTGCTT TTATTTTCTC
 150901 TCTCTGTTTG CCTTCCTCAA ATGCAGGGTA CACAACTGAT TAGTACAGCA
 150951 TCCTGTGATA CCTTCACCTT ATGCAATACT TAAGACATGC TTCCCATTG
 151001 TAGGTAGAAT TGCAAAATTT AACCTCAAAT TTGCAAAATT TGAAATTTAA
 151051 TGATGGGACT ATTCTCTATC AGTGGACCTC TTGATCTTCT CCCTTCAGCT
 151101 TTGAGATTTT TCTCTTTTTT TTTTCTCTTT CTTTTTTTCC CTTTTCTCT
 151151 TCTTTCTTTT TTCTTTTTCT TTTTCTTTCT TTCTCTCTTT CAATCTTTCA
 151201 TTCCTTCATT CTTTTCTTTT TAACTACTAC TGTTCAATTA GTTATTGCTA
 151251 GTTATTTCAGG AACATGTTCT TTGAACAGGC ACAGTCCCTA TCTCAGAACA
 151301 AATCAGAACA ACAAACACTAC TCTCCACAC ATTGGATTGC AGCATCAACA
 151351 CAACAACAAC AACAACAGAA AAAAACAGCC AGAGAAGTAA CTTTTACAGA
 151401 CTATCCATGC TTGATACATT TCAGAAATTA GTTTCTATTT CATTGAAAG
 151451 TTTAGTGGAA TAAATTGGCA TGTTGGAATT TCCTAAGGTA GACCTTGCAA
 151501 TAAATCTTAA AGAAATGGGA ATTATTGTAT TCCCGAGATA TTTCTTTGAC
 151551 AGACTGGCAG GCATCTTTTG TTAATAATAGA CATAATTTAA GAGAGCAGAA
 151601 AATTTGGAAG TCAAACTCTG AGTGAGTAAG GTAGTTTTTC CTCCTGACA
 151651 ATGCAGCCAC TGTGGTAAAA AGTTCCTCTC CCTACTCTTT CCCATCATTC
 151701 TTTTTTCTTT TTGTGAGTAA ATCATTTCCC TGAAGTCTGT CCACAAAACC

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151751 CCTGTGGCAG CAAGTTTGA TAAATGGGAA CTTGGGTCTA CATTCACAG
151801 CTACGGTGGG AAGACTAATT TTGGGGACTA CGCCAACAAA CCATTTATGT
151851 TGCACGAACA GGAGATGGAT TGTTCCTCAT GAGTAATGCT TGTCTGAAC
151901 GTAAGAATTA TGGAGCGCTC TAGGCAGGGA AAAGAACTG TTCTAATAGC
151951 TTAGAAATTT AGATAGCTGT TCATGCTTCT GATTTTCTTG CAGTAACAAG
152001 ATGAATACAA CACAGGTCCA GTTTCCTTAGT CCACTAATTC ACAGCTTCAT
152051 TTCCTTAAGC TGGTTTGACA GTTTGAGTCC ACATTCATAT AATTCTGTTA
152101 CATAAATATA AAGAATTTAC TGCAATTACT ACAACAAAA GCATTTGCAA
152151 AATATTATTA TTTAGAGGTA GGTAAAAAA GTTAGAGGCA AACTTACCAT
152201 GTAATTAAC TTCATAAATC TTATCAGGAG TCACACAGCC AGGTCTTCAT
152251 GTATAGTTTA GCAATTACAT TCTGTCTCTC TCTCTGTATG TACTTCATTT
152301 TGCAACCTCC ATTTAAAGT CCTTAAACAT TCTAAACAGT TCAAGCTTTT
152351 ACTACTTGCA TCCCAGGGCT CTTACAGTGT CTATAGCATA TCTGAACTT
152401 TTAGTAATTT CACATCATTC TTTAATATC TGTCTGAGTT AGTACACATC
152451 TTGCATTGCA GTAAAGGCAA CACCACCTGA ATAGCAGTAG TTTACATAGA
152501 GCTGCATGAG GAAAGAATTT AGAAATTTTG AACTGTTTTA CAGAAAAAAA

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W gene exon 2

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152551 AAAAATGTAT AACCTTATT TCCTTGTCTC CAAGACAGAA ATAGGCAAA
152601 CAGGTAATAT CCATGCTGGG TTTAAAGCAC TCAACTTGGG AATCAACCAA
152651 CCCACTAAAA GTTACTTGCT TAGAAGCGTC AACCAGTTAT ATGGAGAAAA
152701 GTCAGTGCCT TTCAGTAAGG TAGGTAGGCC ATTTATTCAT GTTATCCTGT
152751 GTGTGTCAGA CTTTATGATC TATCTATGAC AACAAACCAT AAATTATATG
152801 CTTTCAAATA TTTTCATTAC ATCTGCAAAT TGTGTAATTA TCTTTAACAT
152851 ACTTCCTGTG AGGTTCTTCT TGAGAATTTA GATATCATGA CTTTATAGG
152901 ATGTATATTT AATTTGTGTG ATTCACAGTT GTGGCTACGC AAAACATTT
152951 AAATTATGTA TTTCCAAATA AAATCAATAC TATGTTCTTT TGACAATGCT
153001 GTGCTTGTAG CTTACACAAT TTTTATGCAT TCTCTCCAAT CGGCTATAGT
153051 TATTTATTGG CATTCACACT GGCAGGCAAC AAACATAAGA CAGATGTCTA

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W gene exon 3

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153101 TCTTGCACTG CAGGAATACT TACAGTTAAC CAAGAAATAC TACAGTGCAG
153151 AACCACAATC AGTTGACTTT GTGGGAGCAG CAAATGCAAT CAGAAGAGAG
153201 ATCAATTCCA CGGTTGAACA CCAGACTGAA GGTAAGCTCT AGCATCTCCT
153251 CTCCCAGTTC TGAAGGAAGC AGTTTGTAGT TTGAACAATT TCTCTGTGCC
153301 CAAAGGCAGG TAAACAATTT AACTCAGAAA GGAAAATCAG AACAGTTTTG
153351 CTGAAGTAAT CATCTGCTGG CAAGCCCTTT CTAGAATTAT CTTTCACCAT
153401 TTGAAAGGGA GAGGAATGTG GTTTCCTCTA TAAATCAAGG TTGTATGTA
153451 TTTATGAATA ATCTCAAGCT AGAAGTATGC CAAATCAGCA CTCTAAATTT
153501 CCTTGTCTTA TGACTTCAGA AACTACGCCA GCATTTACTC TGAAACAGTA
153551 AAGCTGCACA AATATGTAAA CGTTCCTTGT TTTTCTCTAG GTAAAATAAA

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W gene exon 4

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153601 AAGTCTGCTG CCTCCTGGAT CCATAGATTC ACTCACCAGG CTAGTCCTGG
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153701 GATACCAGGC AAAGGCCTTT CAGAATAAAT ACGGTATGGT AACATACTGC
153751 CTTATATACC AGACTGCAGG TTGAAAAAGC AGTAAAAAG ATGGAGGAGA
153801 TAAATTCCTG TCATTCCTTA AAGCCACATA GCACTAAAAT TAGTATATTT
153851 AAAACATACG TTATATCCTT CTTAGCACAT CTTCAGTACA AAGACCGCAT
153901 ACATATGCTA GCACCAAGG CACAAATAAA ATTATCAGAA GCCAGCTTGA
153951 AACAACTTC CATAACCTC TTAAAGCAGG AAAACATAG ATGTGAATAG
154001 AACTGTATGA ACTAGTTCTA TATATTTTCA TTTTAAACCA TACAATGAAT
154051 TGGAGTGGAA CAGAGCTTCC AGTAAATACG TGTCATCCTA GCTGGCTAAG
154101 ATAACCTTCC CAGCCTCCCA GTGCATTCCC AGAAGAGAGG GGCCCTCTGT
154151 AGATCCTACA GCTTCTCTTA GAGCCACAGG GATGTACCTC CATGCTACTT
154201 CAATGTAGTC TTTACTGTTT TGAGTATAAA TAGCAAGCTT TTCATTTGAT

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W gene exon 5

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154251 TTGTTGCAGC ATACAACTAA ACCAGTGCCA ATAATGCACC TGAGTGATAA
154301 ATTTAATTGG ACCTACATAG AATCAGCCCA GATTGATGTT CTTGAGCTTC
154351 CATATGTCAA TAATGAACTC AGTATGTTCA TCCTGCTACC ACGGGATATC
154401 ACTGGCCTAC AAAAGGTAAA GGGTAACTTT AAACCTCAAAT TGCCTGAGAA
154451 ACAACGTTTT CATGCATATC CATGGCAAAG CAATCCTGTT TCTAGGAAGG
154501 AAGGTATCGA TAAGGCTAAA GGAAAAACAA ACCCCAAACT TGCCCAAATG
154551 TTATGAAGCT GAACCTTTTC AATGTTTTGT TTGGTTTTCT TTTTAACTCC
154601 TGGCACGTGG CACCTCGTGC TTCCTCATGT TGATCAGTGC TGGAAATAAG
154651 TAGCCCGAAT CCAACAAGAT AGATCTAATT CCAGCTGAAG AACACGAGG
154701 ACAGAAAGAT AGTTCTGCTG ACTGTCTGTA CTGATTCGGA CAGATATTAT
154751 TACATTAAAA AGAAAAGCAC AAACCTGGACA CCCTCCACTA CTTTCTGTGA
154801 TGTTTAGAGC TAATATACAT GTACACTGCC ACCTTCTGTA AACACACTGA
154851 ACCTGACTTC AGATAGTGAA CTACTGTGAA ATTCTCATTT ACATTAGTGG
154901 GTGTTTTGTA GAAAAAAGAA AAAAAAGTTA TTTTCACTAA ATTCTAAGAC
154951 ACACAGAAAA CAGAAATGTG AGCAGCAAGT CAAATAGACT ATTGTTACTT
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155151 GTACTTGAAA AGTACAATTT TTTTGTCTAC AAAAAAAGC TACAGAATTT
155201 TTGTAGTTTG AAAAGTTCTT AAATAAGAAT ATAAAAGAAA TAACCCCTAG
155251 GGAACAGTTT TTTGAACACT CTGTAATTTT CTGGTTCTCT TTTCAATTAA

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W gene exon 6

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155301 CTGCAGCTAA TAAATGAATT GACTTTCGAA AAATTGTCTG CATGGACCAG
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155401 CAGTAGAAGA GAAATACGAC CTGAAATCTA CTTTGAGCAA GATGGGAATA
155451 GAAGACGCTT TCACTGAAGG TCAAGCTGAT TTCAGGGGAA TGTGAGAGAA
155501 GGCTGACCTG TTTTGTCTAC AGGTTTTTCA CAAGTGTTAT GTGGAAGTCA
155551 ATGAAGAAGG CACAGAGGCA GCGGCTGCCA GTTCAGCATC TCTAGCGTCA
155601 CGAACCCTTG GTGCTACAGT TATTTTGTGA GCAGATCACC CTTTCTCTTT
155651 CATTATCAGA CACAACAAGA CCAAGTGCAT CCTTTTCTTG GGAAGGTTCT
155701 GCTCCCCCTA GAAAATCAGC TATTAATAAA CAAGCCCTTA CAACAACGAT
155751 GAACACAATG TATGCCATGA AGAACACCTT GACAGACTTT GCACTTTACC
155801 ATTTTCCTGT ACTATTGACA ATCTCTTTTA GAAGAGAGCT CAAATTAAAA
155851 ACATGAATTC AAACCTCTGA TTCCTTTTCC TCTGCAAAGA ATCCTAGCAT
155901 CGTATACTGC ACTGTAGAAC ACTGAACTGC ACGCTGAACA ACATGGATGT
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156001 GGCTGATCTA AACAGTACCT TCTGACCCAG TTCCTTTCAC ACGTAAGAAG
156051 AAAAGAAACA GGAGAACTC ATTCCTGCAT ACAGCTGTTT CATCTCTTCA
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156151 AGCTTCACAA CATAGCATGG CTGGTAATGA AACAAAAGTG CAAAATCCTC
156201 TGTGTTGCTG ATACTGGTGG TTTGCTCTTG CACACAAAGG AGCTAACACA
156251 TGTACTTTCT AATCTCTGTC CCTCATAAAC TAGCAAATAC CAAACAATAC
156301 AGAACCAGAG TAAAGTAAAA TACATACCTT GAAATGCTTT CTTTGTTCAT
156351 AACCTTTAAT TCATTCAACG CTGTTGCAGC CCAGCACTGC ACTGCTTTAC
156401 TTGCCTTTTA CTTTGCCACA TATTTTGTCTG CTTGGAGCAA GTGGGAGAAT
156451 AAAGTCTGTT ATGTTAACTC CCTAAGTGCT GTCTAAAAGA TTACATGCAA
156501 ATTCTCCTCT ACATATTCAC TGCTTTCACA GCTTTTACTC CTAAAGGGGA
156551 GGAATTCCTA ATCAGTCATG CACATCTAAG AACACAGGTG ATGCTCCTGT
156601 TTCTCTGAAT TCAGAACAGG GAGGAAAGGA CTGGGTCTCT TAACAGCACT

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MAR-like element

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156651 TGCACACACA CTGACAGCAT CTCACTAGAA ACATCCCTTC CCAGAAAGGT
156701 AGGATACCTT TTTCTGGCA GAGGGAAGAG CGCTGACTGA TAGTGAGTCC
156751 TTTCTGTATT ATTCCACGTG ACCAACTGTG GCCAGGCTCC CTTTGTGGCTC

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156801 TGCTTCCCAA ATGGGAAGGA ACGTAGGGAA GGGCCAATGG CAACCAAATT
 156851 AGAGGGTGAG TCTTGCAATG AGGAACACCA TTTTCCCACC GTAAGTAGCA
 156901 CAGCACTGGG GCAGACTGCC CAGAAAAAAA TTGAGGATTT CCCATTCTTC
 156951 AAAGGGCTGT AGCTGACCTA ATTTACCAGT GGGTCTGCTC CAGGCATGAG
 157001 CTGGACTATG GAAATACCCA TAAACCAGCT TGTGTCTTGT TTCTATCAAC
 157051 ATCCATTCTA CCTTACCACC TCAATTTCTC ATCCTCTCTG GCACCCTTAC
 MAR-like element
 157101 AGCTTGACAA GCAGGGGCAG TTAGCTTGCT TGCTTGCTCT CAAGCATATT
 157151 TCTTTGAGAC TTGGAATCTC CCTAGCTTGT ACTTTCCCAT CAATCAATCA
 157201 CTCAGTGGAC CTTTCTTCTA CCCTGATTTT TTGACAACTC CTCTCATTTG
 157251 ACTAAAGTCA CCACTTGTTT AGTTTCTGGC ATTTCTTCAT TGCCTTGCAT
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 157351 AATCAAGCTT ACAGCAAAAT GCTTGGCACA CCATACAGTT TCCTTCCCTT
 157401 CCTCCTCCTT CCTTCCCTGT CCCCTAGACT CTTACAGATA TTGCCACTAC
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 157601 TCCATGGCAT GCAAGTACTG CACACTAACT CAGTACTCTG CAGTGCTTCT
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 158751 CTGGCTCTGT AATCATTTTA CTAGATTTAT TTAGTTTAAA CAACAGGCCA
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 158901 GATCCACATT GTTCCTTTGA AACGCCTAAA ACTAAAACAT AACATGATGA
 158951 ACAAGGAAGA CAAAACGTGA TGAGATCTTT TTGTGATTCA TTAGAAGCTT
 159001 TGAGTAGGCG GGAACAGTGT TGACATAGGA GAGAAGGAAA AGGAAGTGCA
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 MENT exon L
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MENT exon 1

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160801 GTAGGGGATT TACATATACT AGAGCTCCAG TGTCCCTCTG ATTAGATCAG
160851 AAGATAGCAC AGTGTGTTAT CATAAGGATC CAAACAAGAC AACCATTTTA
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MENT exon 2

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MENT exon 3

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MENT exon 4

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MENT exon 5

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MENT exon 6

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163701 ATACGTGAAA CGTGAACCTCA GTATGTTTCA CCTACTTCCT GACGACATCA
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MENT exon 7

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167351 CTCACTTATC TAACCCATCG TTTGTCAGCC TGGCCATAAG GATATCACAG
167401 GAAAAAGTGT TAAATGCTGT TTCTAAAGTT AAGGCAAACA ACATTTAGTA
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169951	AATAACCAGC	TTTATTTTGA	CAGTCTTAAA	AATTCATATA	AATTTTCCAG
170001	AATGGAGAGG	GTAAATGGTA	ACTTAAATGT	CATGCAGGGA	AATGGAGCAC
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170151	GAGAGCACAA	GAGTTTCCTC	ACTTGCAGGC	AGGGTGCCCT	AATCACCAGG
170201	CTACCAGCTG	ATTTAGGATC	AGAGGACTGA	ACACAGAACG	CAGATGATAA
170251	TGCACTCCTA	CTGATCCTGG	AGTTGAACAC	ACGTGACTGC	ATGACTCCAT
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171851	CTTGGAGTAT	TGCAACTGCT	CTCGCTATGG	TCTATCTGGG	TGCAAAAGGT
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172001	ACAAAAAGGA	GCAACATGAG	AGAACAGTGA	TCCGCCATCA	TGTTGGGTGC
172051	AAGAAAAAAC	ACTGCATGCA	GTCCTGCAGG	ACACTGTTGT	TCCAACCTAT
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172151	TTCTGGCAGA	GTGAAGCTAT	GGACATTAGA	GA CTGTCTTC	TCATTCTCCA
172201	CACCCAGTTA	GTAAGTCCTC	TGAACCCAAG	CTTGGCTGCA	CAGCAGCAGC
172251	AGCAACATCT	TTGCTTGTGA	CATGGTTAGT	CCATAAATAA	GGTAATACAC
172301	CCATGAAGAA	GGGAAGGTTT	AGATTGGATG	TCAGGCGGAA	GTTTTTCACA
172351	GAGAATGGTG	AGGTGCTGGA	ACAGGCTGCC	CACAGAGGCT	GTGGATGCCC
172401	CTTCCCTGGA	GGTGTTC AAG	GCCAGGTTGG	ATGTGGCCCT	GGGCAGCCCC

172451	GTCTAGTATT	AAATGTGGAG	GTTGGTGGCC	CTGCCTATGG	AAAGGGATTG
172501	GAGCTTCATG	ATCCTTGGGG	TCCCTTCCAA	CCCAAGCCAC	TCTACGATTC
172551	TATGAATAAT	GGGGATATAC	TAGAAATGAA	AATATGATAT	CATTTATAAC
172601	CACCTTTGCA	AACTTTTCGG	TGATGTACTC	CTAGATTATA	TGCATTTACA
172651	TAAATGCATT	TATCTGTGTA	ATGTACTGTA	GAGTTGTACA	TTGGTGCCTC
172701	AATAGTAAGA	CTACAAACCA	TCCTATGTTG	TTTGTTCCTG	CTGATAACAA
172751	TCTGAAAATA	AATTCCACAT	TGCTAAGCAT	GAATTGACCA	TTTCTCCAAA
172801	TCAATCCATG	TCTGAGCAAT	CACATTGATC	TGTTATTAAG	TAGTAAATGA
172851	CTAAAAATTAA	TATAACTATG	ATACGGTTAT	AGAATCTAAA	TCTAGACCGA
172901	GGTCTTGTTT	TCTATAACTT	TAATAGACTA	ACATTTGTAC	GATGGCTAAA
172951	TTATCCTAAG	TAGAAAACTA	ACATCATTAC	GTAACACTAG	AGCACTTCTA
173001	TCTTCACAAA	ACAAACTGTC	CTTAAGAAAA	TTTATCACTG	CCACAGGTTT
173051	TTCATTTTAA	CCAGACTGCA	AGAGAAGAAA	GTCTTCTCTG	GATGACAGCA
173101	CCTTCTCTGC	GGAGCCCAAA	GAGAAGAGAC	ATGGTATTTA	TTTTGACAAAG
173151	GCTCACAGAA	ACAAATCTCG	GAGAATGGGA	CAGCACAACT	GCCTTAACCC
173201	TCTGAAATTT	GTCTGTCTAT	ACCTACTGTC	CTATTGCAGT	AAGAACTATA
173251	CATAAAAAAT	GTGAACAAGC	AGGTAATATT	ACTGTAAAAC	TCACGAACTC
173301	AGAACTTCAA	AGCAGAACAG	AGACACCAGA	AGCATTCTGA	TTGTCTTTTA
173351	CACCTTGTTA	CTTGCTTTTA	GCTGCTCTAT	GGCAATAGGA	ATACCTAATA
173401	TTTTACTAAC	TTCAGGATTT	TTTTTTTTTT	CTGGGCTGTA	AAACAGCCAT
173451	TGCCTTCACA	TCTGACTCCA	GTCTGCTCT	CTTAAACTCT	GTTCCACCTT
173501	TGCTATGCAT	GCACACATCA	GGCAAACAAA	ATTCCCCTGT	AAGCTAACAC
173551	AACTGATTC	ACCTTGCTC	ATCAGCTCCC	CAGAGACTTG	ACAGCAGGAG
173601	GAACTGCACA	GAACTCCTTA	CGCCTCAAAG	GTCTGTCAAC	TCAAACAAGC
173651	TGCAATTCTT	TAGCACAGAA	ACTAAGAAAG	CTCAAAGAAA	CCAAGTTAGA
173701	AAAAGTGGAA	ATAAAAAGGA	GCAGTTACAT	CATTCTCCAT	CTAGATGGCC
173751	GTGGATTAAT	ATTTAAGATA	AATCATTATG	TCCACATTGA	TTTTAGCTAT
173801	TCACTGCCTT	TCTAAGTTGC	ACAGCAAGGT	CTGCCTGATG	TAGCCTTCCA
173851	GACATTTCTC	TCCATTACCT	CTTCACTATG	TACCCATTGC	CTTGCAAAAC
173901	CTATCTACTA	TCCGTGTTCT	TACCAAGTTC	TTCCCCACAT	GTCTTTCTG
173951	AAAGCCTGTA	CCTCTGCCTG	TGTGAAAAAA	TACCAGAGGA	AGGAATGCCT
174001	CCTCACCAAT	CTTATGACAA	GCCCCCATGC	ATCAGCAGCA	AAGAATCTCG
174051	GTGTCTCACA	TGTAGCGCAT	GGTACATGCC	ATGGAGCAGG	AAATTATACT
174101	GAAGCAGCTT	ATCCCTACAC	TACGAAAGCA	ACAGCTGACA	AGCAAGCTCC
174151	TGCTCCCTAA	AACCATCACC	AAGGACATTC	TGGACAGGTT	CCTTCCAACA
174201	TCCAAGCAGT	AACAGCAAAA	TTCACATCAA	ATAGAAAATT	CGAATCAACT
174251	CAATTACATG	ACATCAGTAT	CTGTCTGAAC	AGAGTAGCTC	CTCAAAAGCT
174301	GCAATGTTGC	CTTAATGATT	TTTGTGATAA	TCAAAATTAG	GCTTGACTGT
174351	GACTGGAATG	AGATGACCCA	ATATCCTGGG	TGCACCATCT	GAGGACAGCT
174401	GATGTCCTCA	AAGGTGTAAG	CAGCTCCGCA	GAATCAAATC	ATAACCCAC
174451	AGACATAAAA	CAATGTATCC	AGTTACACAC	AGTGCTGCAA	AAGTACCAGA
174501	TACCCGAAGA	AGAGCTCCAT	CCCTGCACAC	ACTTTTTTAA	TTAAAATGAC
174551	CTGGGGATTT	TAAATAACCA	TAGAAAGTGT	AATGCTTCAG	CCAAAAATAT
Z1 gene exon 2					
174601	TTCAATACTA	ATTGGTGCCT	CTTTCCAAGG	GTCTTGAGTA	TGAGGAAACT
174651	GAAAACATCC	ACTCCGGCTT	CAAAGAAGTC	CTGTCTGCCA	TCAGCAAACC
174701	TAGAAACACT	TACTTGCTGA	AAAGTGCTAA	CCAAGTGTTC	GAGGACAAAA
174751	CCTACCCATT	ACTGCCTGTG	AGTTGAACGT	TTCTGCTTAA	GAATGTTTTG
174801	ACAAAGAGTA	TTTGACGTAC	ATATTTGACA	ATCATAATTT	TCCAAATGTT
174851	CTGCCTTTTA	AATCTACTGC	AGCCTTTAAA	ACTGTAAGAG	TTCTACAGTT
174901	GAACATCAGA	AAGCTCCTGT	CTCTTTTGAG	CCTATTTCTT	GTTAGCATCA
174951	CTGTTGGTTT	ACTTCTCCTC	TAAAGGAAGC	TTCTCCATAT	CAGTGGTCAT
175001	CTTCTCCCC	CTTCTCATA	TCTATTACAT	TCTAGCATTT	CTGAGATTGG
175051	AGGCCAGAGC	TATATAGAAA	AGTCACACCA	TACCTTTACA	GAGCGGCATA

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175101 TTAACGTTCT CCCTTTTATT AACTGTTCAT TTCCTTCAAC TTTTCACATC
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175251 TATTAGTATG CTTTGCTGGA TCATTTTCAG ATGTTTCAAT ATTGATACTG
175301 TAATCTATTT CCTTCTTCTC TTAGTTTCTA GCCTTTTAAA CAAGATCTTT
175351 CTCTGTAGTC CCACGGATAC TCAGCTTCTT CAAAAGCCTT TGGTGAGAAG
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175451 TCTCATTTGC AAGCTTCTTT ACACCTTCAA AAACCTCCAA AAGATTTCATG
175501 ATGTAGGACT TATTGTTACA AAATGCTGTT CCAACACATC ATGCTTACCT
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175601 TTGTAATTCT GTGTATCTTT GAAATCTTTT TAAGAAATGG CACTGTATTA
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175951 GGCAGCTTGA CTCTGAAGCA AATCTTAAAA CATGTGTTTCA ACTGTCCTTG
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176801 ACTATTTTGT TGCTTAAATT TAACATATA AGCATACATT TTCCAATTCT

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Z1 gene exon 3

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176951 ATTCTTGCGT TGAAAACGAA ACTGAGAGTA AGTATCGCTC TGATGGCTTT
177001 TTCTTTTCTC ACTTCAAAAT CATTTGCATT TCCACTTGAA TTGCTCTTGC
177051 AGTAAGGGAT CCATAAAGGA TGGAAGTGT GGGGAAATGA TGAACAAATT
177101 GCAGTTAAAT GTCTTGAAGA AAGCCAACCA CCAAACTAA CTGCTGCCCC
177151 TTGCAAAGTT TTTCCCTTGA TTTTTCATGT CATAGTCTCT TCTGAAGTAT
177201 TTCTGTTTCA AAGGAAGCAG AGTGGATACT ACATGGCTCC ACTCTGATCA
177251 GTGAAGGTTT TACTTCTGCA AGCTTCAACT GGTTGCAGCC AACTCCAGAG
177301 AACTTCCACG CTTTACACAC TTCTTAACAT CTTTACTAC TAAAACGTAA
177351 ATAAATATGG TTTAAAAAAC AGTGATGCTT CAAAAGCCAT TTATGTATGT
177401 ACGCTGTGAA AAATGCACAG GGAAAAAATA TCTCTGAGTG TAAACACTTT
177451 TGTTAGATAG CTAGGCATAG AGAAAGCACA TCTGAAATTG GTGAGTTGTG
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Z1 gene exon 4

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177651 AAGACACATC CGAGATGCCC TTCAGATTAA GCAAGGTAAA TTCCTTCAAA

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 178651 TCACAGCAAA TATGGTCCAT AGGTAAATTC AATCAATCAG TGCTGTCCGG
 178701 AAGCATACAA AAGAGTTGAT GACATCCAGA GAATGAAAGT CAGCATT TTTT
 178751 TTCCCCTCCC AATCAACACA TTCACTCAAG AAATGTAAAG TTTTGGGGAA
 178801 AACTTGAAAC ATACAAAAGTA GTTTCTTGTT TACCAAAGCT AACTCTTTCA
 178851 AAAGAGTGAG AAATACATTG CATGTAATTA TGTATCAGG TGGTGTCTGT
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 179001 TACAATTTTT TTTTGCCTTC AGTTCAACAA AGCAAGTAAT CTTTACCATT
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Z1 gene exon 5

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 179901 ATCCACCTCC AAAATAATGA ATTATTCTGA AGGTTCCTC TACACCTCAC
 179951 TGCATTTAAG GAAACAGATA GAAGTACAGG TCACTCAGCA CTATGCAGGA
 180001 TCACATCCTA AGAATATGCA GCACATTTCA GCTGTACTCA CAGCTGGTAG
 180051 TTGGACCTTT TAAATCTAGA GCATTAGACA CCAATGTATG CATGCCTTCT
 180101 TTTTCTGTT GCATTATGAC TATATTCTTA TAAATTCAT TGCAGGTAGA

Z1 gene exon 6

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 180251 AATTATGATC TTACATCCAC TTTGAGCAAC ATGGGGATAC AAAATGCTTT

180301 TGACCCCTGTT CAGGCTGATT TCACAAGGAT GTCAGCAAAG AAGGACTTCT
180351 TCCTATCAAA AGTTATTCAC AAAGCTTTTG TGGAGGTCAA TGAAGAAGGT
180401 ACCGAGGCAG CAGCTGCCAC AGGTGTCCTG GTGTTGAGGT CAAGAACACC
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180801 TCAGGTGTGC ATCTTCACCC TTCCACCCTG CCATAATTAG CCCCTGCTCC
180851 TCTGTAGCTC TTGACTAGTT CTTTTTGTTA CAGAGGCACA CACAGCCCAA
180901 GCTTAAGTCT TTACCACTTC ACTTCCATTC TACTGATTGC CTGAAAGACA
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181351 GTGGAGGGTC TGTGTTGTTG TTTTCTGCGG GAAACACGCA TTGGTTTTTT
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181451 CGGGCGCGGC CGCCGGGCGT TGACCGGGTG CTGGAGGCGG GAGGGGCCCC
181501 GCAGAGTTCC GCACCGCTGG AATCCATCCC TGTCATCCAG CCCTGCCCTC
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182151 ATAAACCGTT TACTTTATTG CGTCTGTTTC CATCGTGTAG ACAATAAAAG
182201 GCAAACCTGCA GTGGACTTTG ATTTTGTACC ACAGCAGGAA ACCCCAGTAA
182251 TCTGTAATGC TGACCAGATA AATTTGTTT GAATATTGTA GATCGAGTCA
182301 TTCAGTTGGA TTCTGGCAGA CTGACTGCTA GGTCTAGAAC ACAAGTGAAG
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182601 AAGGGCAAGA AAGCCGTGAA GGGTCTGGAG CACAAGTCTT ACTATTGAGT
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182701 GACTTTATCA CTCTGTACAG TGACCTGAAA GGAGGTTGTA GTTGGCCTCT
182751 TTTCTGGGT AACAGCAATA GGATGAGAGG GGATGGTCTC AAGTTGTGTC
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182851 GGCACCTGCA CAGACTGCCC AGGAAGGTGG TGGAGTCACG TCTCTGGAGG
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 183101 CCATGGATAG CCTCAGTGCA GCAAATTCCA CTTTGTCTCT TGACCTTTTA
 183151 AATGAGCTGC GTGAGAAAAG CAGCACAAAG AATCTATTCT TTTCTCCTTT

Z2 gene exon 1

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 183251 CTGAAGCCCA GATAGCAAAG GTATGTATCC AAACGTAATG TATTGGATTT
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 183351 GTATTACAGT CTGTGACCTC TAATTGCTGA ATTGTTACAG TCATTCTGGC
 183401 CTCAGAGGTC AGAAGTCTTC CTTAGGTATG TACATAAGCA GAACCTATTT
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 184751 TGCTGATGCA AGTGTGTCAG AGATTACGTG GACTCCACAG AAGGTATTTG

Z2 gene exon 2

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 184901 CAGAACTGCT AACCGACTTT ATGGAGAAAA GACATTTGAG TTTCTCTCAG
 184951 TAAGTAAACA TTAAATTTGG GTGTTGTGAA GTATAATGTA CTTGCTAGCT
 185001 ATTCCCCTTG AAGGTTAGAT AAAGGCTTTG GGTTTTACTC TCCAAATTTT
 185051 TCTAGGCTGA GACTTACAAC CTGAGAGTCT ATGCAAAAAG CAGGATGTGA
 185101 ACAGAATGGA GAAGCTACTT TTAGATTATA TGAATGCACA ACTGGTGCAA
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 185201 GGTTCTAGGA TCAAATGAAT GACAAATCTC CTTGCCTTTG ATAACCTGTA
 185251 GCTATGATGA AAACAACGT TACTGCTGTC CAGCATGGGC AGAACTTTTC
 185301 TTTTCTCTTA ATTAAACAAT CCAGAGAACA TGCTGAGAGG AGTATGTGAC
 185351 TCTTAATATT TTCCTTATAA GTATATATAC ACAAGAGGGC ACAGGTACGT
 185401 TGCATATACA TTACATATAC ATTATAACAT TGTATGTTCT CTCACTCAAG
 185451 CAAAAAGAAC AAACGGAAGA AACAAAAAGA AACAAACCAG ACAATCATTT
 185501 CTCAGTTGAG TACTGTAGAA TGTCTGGTG TATTAAAGAA GACATTTGAC
 185551 TTCTTAATAA CAAAGAGGAA GATAATTCCT AGCTCAGATG GCTAATAAAA

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185601 CAACTGATAA GAACATGTCA GACAAAACCT GAATGGCTTT ATATCAAGCT
 185651 GGGGGAAGAG AGGATATAGA TTTTCTCAG TGTACTTAAA AACATCTGTG
 185701 GCTGAATGTC AGTAAAATGC ATTGCTAAAA AGCTGTTTTTA AATGTTTCATG
 Z2 gene exon 3
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Fig. 1

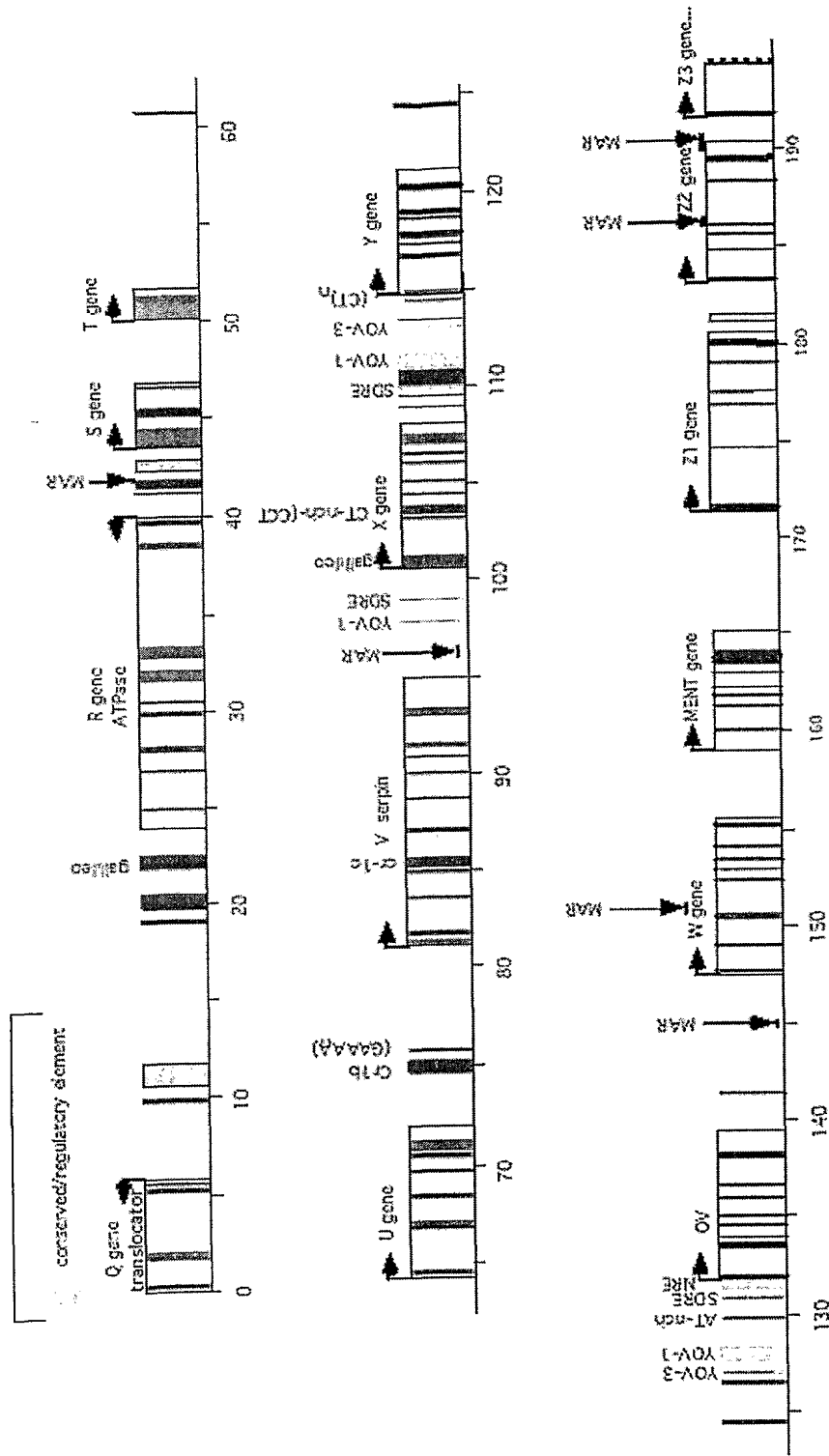


Fig. 2

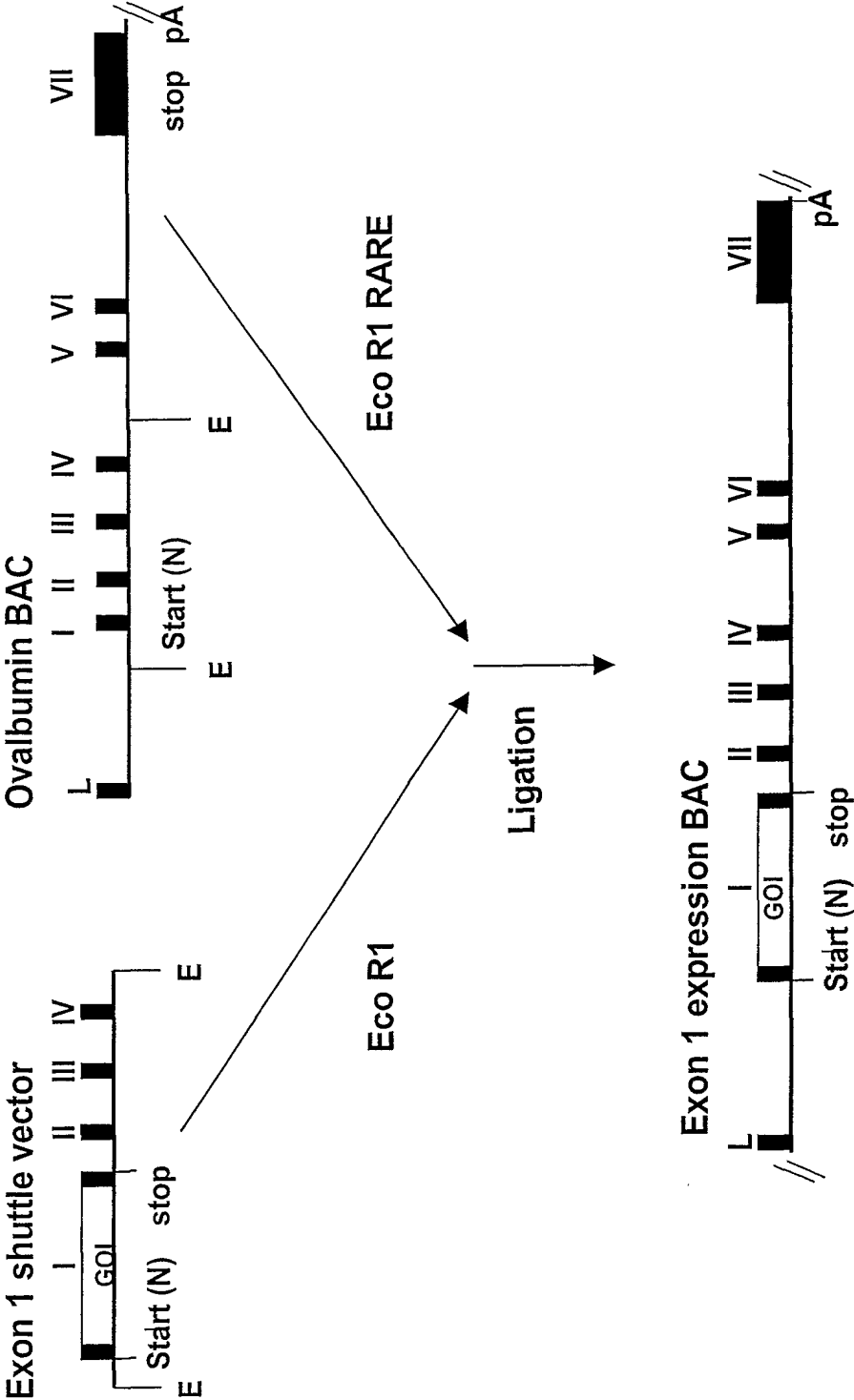


Fig. 3

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SEQ ID NO: 2

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FIG. 4**SEQ ID NO: 3**

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Fig. 5

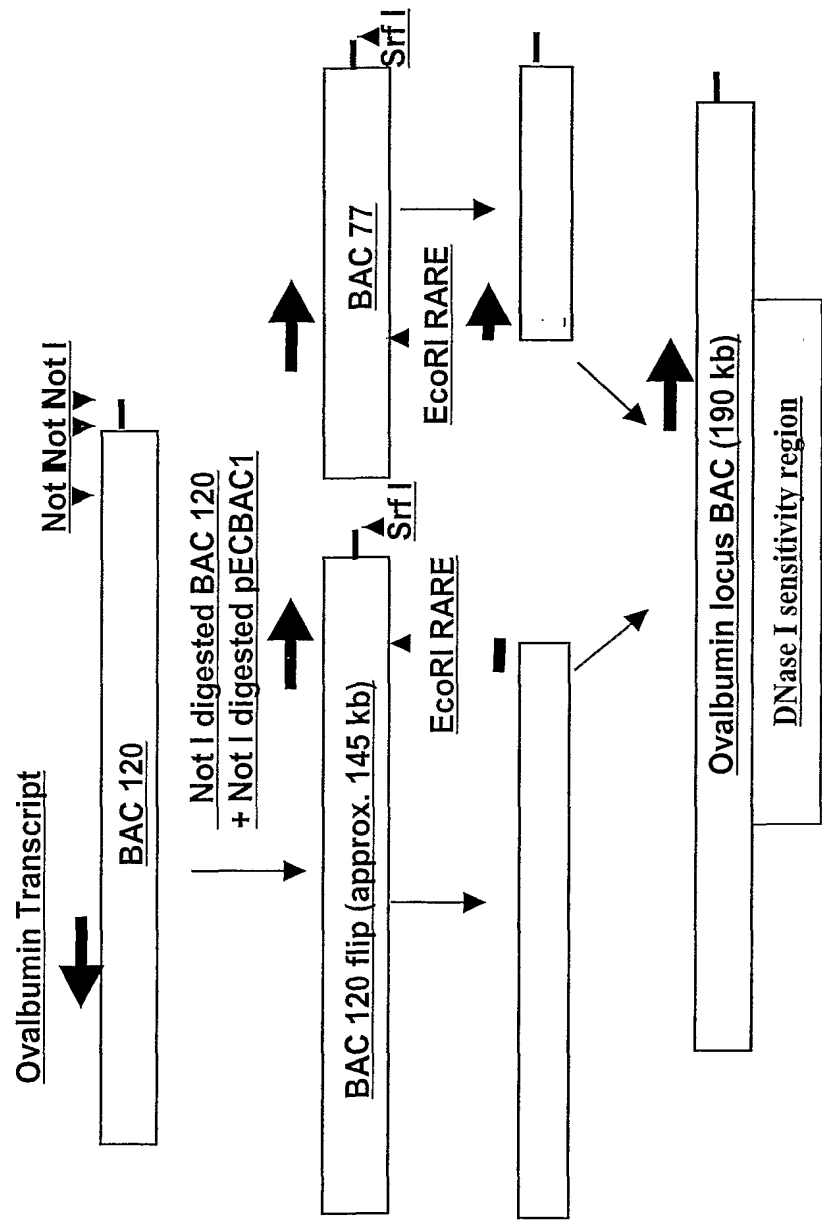


Fig. 6

Chicken Ovalbumin Locus.ST25
SEQUENCE LISTING

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<120> Chicken Ovalbumin Locus

<130> U022 1060.1

<160> 3

<170> PatentIn version 3.2

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Chicken Ovalbumin Locus.ST25

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Chicken Ovalbumin Locus.ST25

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Chicken Ovalbumin Locus.ST25

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Chicken Ovalbumin Locus.ST25

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Chicken Ovalbumin Locus.ST25

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Chicken Ovalbumin Locus.ST25

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Chicken Ovalbumin Locus.ST25

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Chicken Ovalbumin Locus.ST25

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Chicken Ovalbumin Locus.ST25

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Chicken Ovalbumin Locus.ST25

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Chicken Ovalbumin Locus.ST25

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Chicken Ovalbumin Locus.ST25

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Chicken Ovalbumin Locus.ST25

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Chicken Ovalbumin Locus.ST25

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Chicken Ovalbumin Locus.ST25

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Chicken Ovalbumin Locus.ST25

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Chicken Ovalbumin Locus.ST25

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Chicken Ovalbumin Locus.ST25

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Chicken Ovalbumin Locus.ST25

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INTERNATIONAL SEARCH REPORT

International application No.

PCT/US03/39244

A. CLASSIFICATION OF SUBJECT MATTER

IPC(7) : C12N 15/85

US CL : 435/325; 800/8, 21

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 435/325; 800/8, 21

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
east, biosis, medline, caplus

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	CHONG et al. The chicken lysozyme chromatin domain contains a second, widely expressed gene. Nucleic acids Res. 2002. Vol. 30. No. 2. pages 463-467. See entire article.	1-70
A,T	WO 02/079447 A2 (AVIGENICS, INC.) 10 October 2002. See entire reference.	1-70

☐ Further documents are listed in the continuation of Box C.

☐ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T"

later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X"

document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y"

document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&"

document member of the same patent family

Date of the actual completion of the international search

17 May 2004 (17.05.2004)

Date of mailing of the international search report

06 JUL 2004

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